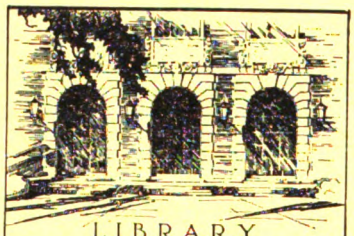

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CONTENTS OF VOLUME III

ART AND MUSIC

Art and Collecting, 304
Book Illustration, 111, 176, 240
Decorative Art, 436
Drawing, 109, 237, 301, 434
Music, 173, 367

BUSINESS AND COMMERCE

Book-keeping, 118, 182, 244, 310, 374, 440, 500
Choosing a Career, 51, 115, 180, 242, 308, 372, 438, 498
Commercial Training, 49, 113, 178, 306, 370, 437, 497
Shorthand, 55, 247, 503

ENGLISH LANGUAGE AND LITERATURE

English Literature:
Age of Pope, The, 185
Eighteenth Century Poets, 249, 313
Eighteenth Century Prose, 441
English Language, 127, 190, 254
Journalists, The Early, 121
Seventeenth Century Men of Letters, 57
Philosophy, 320, 377

GEOGRAPHY

Central America, 226
North America, 289, 354, 420, 486
South America, 34, 92

HISTORY

Birth of Modern Europe, 131
Britain's Story, 1, 63, 258, 381, 449
Reformation in Germany, The, 193
Renaissance, The, 323

LANGUAGES

French, 29, 83, 159, 218, 279, 344, 414, 479
German, 31, 86, 162, 220, 281, 347, 417, 481
Latin, 26, 81, 157, 216, 277, 342, 412, 477
Russian, 89, 224, 285, 350, 484,

MATHEMATICS

Algebra, 42, 101, 169, 298, 359, 424, 490
Arithmetic, 39, 99, 166, 231, 295
Geometry, 45, 104, 233, 362, 427, 492
Mechanics, 430

SCIENCES

Anatomy and Physiology, 407, 473
Botany, 153, 212, 274, 334, 394, 461
Chemistry, 6, 69, 139, 199, 263, 328, 389, 455
Electricity and Magnetism, 12, 78, 146, 205, 266, 332, 392, 459
Ethnology, 19
Light, 8, 73, 141, 201
Sound, 398, 465
Zoology, 14, 148, 207, 269, 338, 403, 469

SPECIAL SUBJECT

Food Stuffs, The Story of our, 494

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GUIDE TO ILLUSTRATIONS

ART AND MUSIC

	PAGE
Animals in Decoration, Use of	177
Brunnhilde, The Awakening of	366
China for Collectors, Specimens of	305
Corot's "The Bent Tree"	241
Foliage, Studies in	108
French Types, Sketches of	111
Furnishing: a Simple Room	436
Human Figure, The	303
Human Skeleton, Comparative Measurements of the	302
Le Havre: Bassin du Commerce	112
Old Sheffield Candlestick	305
Paganini	369
Vicat Cole's "A Study in Foliage and Reflections"	240
Watteau's "The Music Party"	174
Wedgewood Black Basalt Teapot	305
and many diagrams	

BUSINESS AND COMMERCE

G.P.O. London, A Busy Period in the	52–53
Postal Censor, Some War Trophies of the	117
Wheat Pit at Chicago, The	499

ENGLISH LANGUAGE AND LITERATURE

Addison, Joseph	125
Boswell, James	255
Burke, Edmund	443
Burke Receiving Punishment for His Apostasy	448
Burns and Highland Mary	319
Burns as Poet-Laureate of Lodge Canongate-Kilwinning	316
Burns, Nasmyth's Portrait of	317
"Cheshire Cheese," Interior of the	255
Clarendon, Fall of	61
Cowper, William	315
Crabbe, George	315
Defoe, Daniel	123
Defoe in the Pillory	124
Gay, John	189
Gibbon, Edward	443
Goldsmith, Oliver	251
Gray, Thomas	251
Johnson at Lord Chesterfield's	444
Johnson, Dr. Samuel	253
Johnson's Birthplace; Chair; Pew; Houses	255
Kant, Immanuel	320
Literary Party at Sir Joshua Reynolds', A	447
Locke, John	60
Osborne, Dorothy	59
Pepys, Samuel	60
Pope with Martha Blount, Alexander	187
Steele, Sir Richard	125
Stoke Poges Churchyard	250
Temple, Sir William	58
Thomson, James	189

GEOGRAPHY

	PAGE
Argentina, Cities and Plains of	96–97
Brazilian Sugar-Cane Plantation	94
Buffaloes at Wainwright, Alberta	294
Chile and Peru, Coast of	95
Cotton Bales in an Alabama Port	489
Fauna of Brazil, The	37
Fraser River, Picturesque Cañon on	356
Grand Fall on Hamilton River, Labrador	292
La Brea Lake, Trinadad	230
Lumber Transport, Cheap	421
Maps:	
Central America	226
North America	291, 355, 487
South America	35
Mount Robson in Canadian Rockies	357
New Panama	229
Panama Canal and Trade Routes	227
Pilgrim Fathers and the *Mayflower*	288
Pittsburg, Pennsylvania, View of	488
Prairie, Typical	293
St. John Harbour, New Brunswick	358

HISTORY

Baron's Hall, Christmas in the	68
Boabdil the Moor, Surrender of	130
Caxton's Press in Westminster Abbey	324
Charles V., The Emperor	136
Columbus, Departure of	133
Columbus received by Ferdinand and Isabella	133
Cranmer at Traitors' Gate	388
Erasmus and Thomas More at Court	327
Henry VIII. on his way to the Field of the Cloth of Gold	262
Henry VIII. and Cardinal Wolsey	387
London of the Tudors, The	260–1
Luther before Charles V.	192
Luther burning the Pope's Bull	196
Luther translating the Bible	197
Mary Queen of Scots in France	452
Mary Queen of Scots at Fotheringay	453
Philip II. of Spain	451
Pope Leo X.	195
Princes in the Tower, The Little	5
Queen Catherine, Death of: Trial of	383
Red Rose or White?	3
Reformation, Dawn of the	380
Richard II., Death of	65
Russell, John: First Earl of Bedford	259
Savonarola, Girolamo	137
Spanish Inquisition at Work, The	135

MATHEMATICS

Condensation of Steam, Discovery of	432
Instruments of Exchange, Stages in Evolution of	167
Watt and the Newcomen Engine	433
and many diagrams	

SCIENCES

ANATOMY AND PHYSIOLOGY

Anatomy, A Lesson in 408
Jenner, Edward 410
Liston, Robert 410
Plague, A Prescription against the . . 411
Vertebrate and Invertebrate . . . 475

BOTANY

Bean, Germination of a 213
Beech, Birth and Early Growth of . . 215
Crescograph in Botany, The . . . 337
Pea, Germination of a 275
Plants Absorb Water, How . . . 463
Seeds, Germination of 275
and many diagrams and drawings

CHEMISTRY

Calcium Nitrate, Production of . . 70
Carboniferous Britain, Tropical Vegetation in 331
Diamonds, Searching for. . . . 329
Fern Frond on a Piece of Coal, Imprints of 330
High Explosive 7
Lord Rayleigh in his Laboratory . . 391
Nitrogen from Nature, Wresting . . 71
and many diagrams

ELECTRICITY AND MAGNETISM

Leclanché Cell, Component Parts of . 267
Magnetometer, The Declination . . 13
2-Ohm Coil, A 333
Voltmeter, A 332
and numerous diagrams

ETHNOLOGY

Antarctic Endeavour, A Pictorial Record of 24–25
Railway Engine of Yesterday, The . 20
Railway Engine of To-morrow, The . 21

LIGHT

Day Light and Artificial Light . . 143
Einstein's Theory of Light . . . 11
Eyes of Man and Monkey . . . 75

LIGHT (*continued*) PAGE

Match, Evolution of the . . . 457
Spectroscope, The 145
Spectroscope, The Principle of the . . 203

SOUND

Sound and the "Movies" . . 400–01
Sound in Liquids, Velocity of . . 466

ZOOLOGY

Carrion Crow and Rook . . . 15
Cod Multiply, How 405
Cuckoo, Parent of a Usurping . . 149
Deep Sea Fish 470
Denizens of the Seashore . . . 471
Dog Fish 470
Frigate Bird 272
Gannets on the Bass Rock . . . 273
Golden Eagle 211
Grey Parrots and Nestlings . . . 151
Heron, The Common 271
Hornbill 150
Jackdaw 15
Jay 15
Kingfisher and its prey 149
Little Auk 339
Long-Eared Owls 152
Mound Birds or Brush Turkeys . . 209
Ostrich Chicks 340
Pelicans 271
Penguins, Antarctic 341
Razorbills 339
Roach, Development of the Air Bladder of the 404
Spoonbill 270
Swallows in the War Zone . . . 17
Thresher Shark 472
Trawl and Herring Fishing . . . 406
Trout, External Features of . . . 403
Vulture 210

SPECIAL SUBJECT

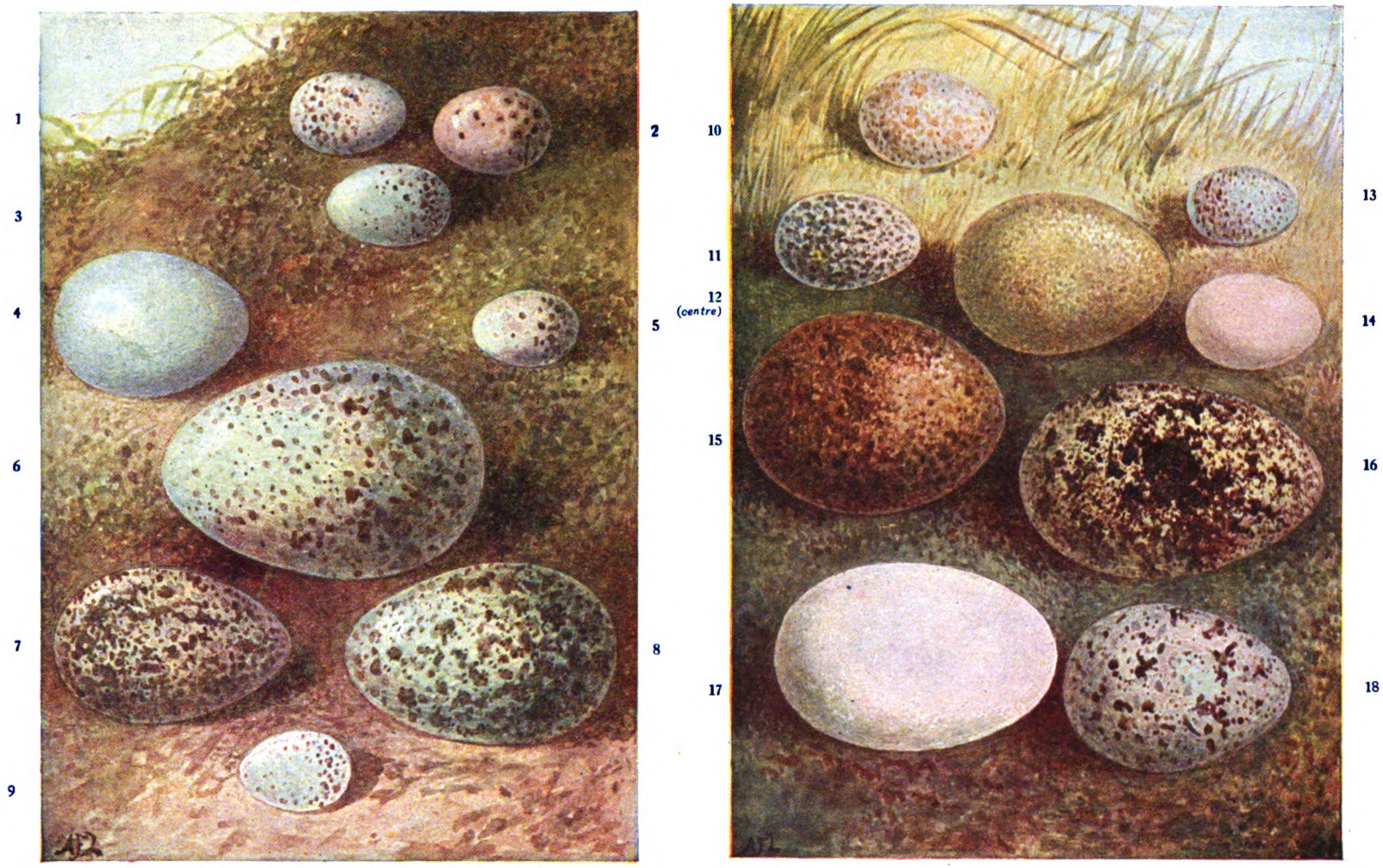
Annual Consumption of Imported Food per Family in Britain 495

COLOURED PLATES

Chemical Reactions of Metals, Some Characteristic . . . . . *To face page* 121
Eggs, Some Familiar Birds' . . . . . *To face* Title Page Vol. III
Fish, Various Species of . . . . . *To face page* 377
Founding of St. Paul's School . . . . . *To face page* 249

BLACK-AND-WHITE PLATES

Feeding the Zoo, Problem of . . . . . *To face page* 185
Grand Cañon of Colorado . . . . . ,, ,, ,, 313
John Bull, Farmer . . . . . ,, ,, ,, 441
Sovereign, Fluctuation of the Value of the . . . . . ,, ,, ,, 57



EGGS.

1, Goldfinch; 2, Chaffinch; 3, Bullfinch; 4, Starling; 5, Linnet; 6, Raven; 7, Magpie; 8, Rook; 9, Wren; 10, Robin; 11, Sparrow; 12 (centre), Jay; 13, Redpoll; 14, Wryneck; 15, Kestrel; 16, Grouse; 17, Ringdove; 18, Jackdaw.

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Continued from Vol. II., page 456.

HISTORY:

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BRITAIN'S STORY.—V

[*The introductory chapter of* LORD MACAULAY'S "*History of England*" *has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages* (*printed in closer type*) *have been interpolated in order to meet the requirements of the student.*]

COOPED up once more within the limits of the island, the English people employed in civil strife those arms which had been the terror of Europe. The means of profuse expenditure had long been drawn by the English barons from the oppressed provinces of France. That source of supply was gone: but the ostentatious and luxurious habits which prosperity had engendered still remained; and the great lords, unable to gratify their tastes by plundering the French, were eager to plunder each other.

Wars of the Roses

The realm to which they were now confined would not, in the phrase of Comines, the most judicious observer of that time, suffice for them all. Two aristocratical factions, headed by two branches of the royal family, engaged in a long and fierce struggle for supremacy.

As the animosity of those factions did not really arise from the dispute about the succession, it lasted long after all ground of dispute about the succession was removed. The party of the Red Rose survived the last prince who claimed the crown in right of Henry IV. The party of the White Rose survived the marriage of Richmond and Elizabeth.

Left without chiefs who had any decent show of right, the adherents of Lancaster rallied round a line of bastards, and the adherents of York set up a succession of impostors. When, at length, many aspiring nobles had perished on the field of battle or by the hands of the executioner, when many illustrious houses had disappeared for ever from history, when those great families which remained had been exhausted and sobered by calamities, it was universally acknowledged that the claims of all the contending Plantagenets were united in the house of Tudor.

Henry VI

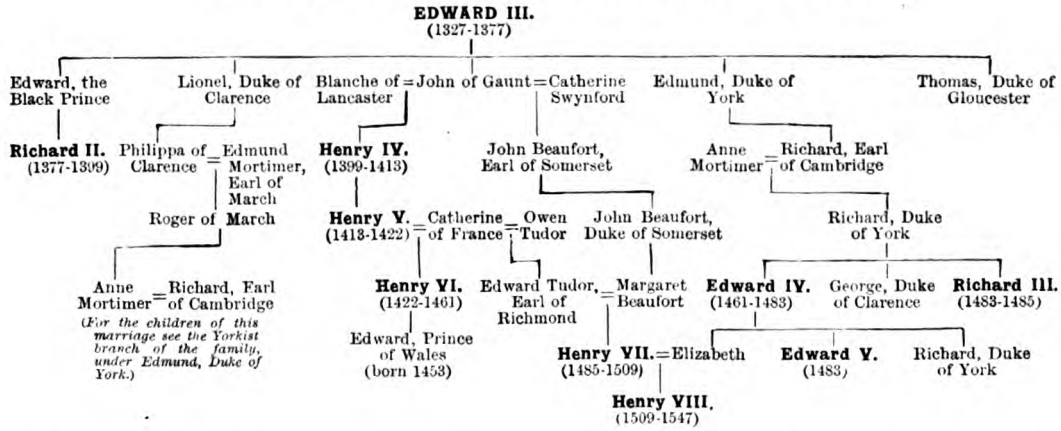
The *Wars of the Roses* (1455–1485) were so called on account of the distinctive badges worn by the houses of York and Lancaster, whose rival dynastic claims were the ostensible cause of the struggle.

The Yorkists took as their cognisance the white rose; the Lancastrians the red. Both these families were descended from the sons of Edward III.; and (as the genealogical table on page 2 will make clear), whilst the former could show strict hereditary right, the latter had had possession and Parliamentary title since the accession of Henry IV.

The loss of France immensely weakened Henry VI.'s position in the country, and feeling ran strong against him, and in particular against his ministers, the Duke of Somerset and the Earl of Suffolk.

The discontents naturally rallied round the opposition branch of the royal house. The Duke of York himself, however, was not openly disloyal. As heir to the house of Mortimer, he knew that, owing to the fact that Henry VI. was childless, he had a better claim to the throne than any member of the house of Lancaster. He was content, there-

THE HOUSES OF YORK AND LANCASTER



fore, to wait his time ; and when in 1453 Henry VI. went mad, he did not imagine he would have to wait for long.

But in 1453 Henry VI.'s queen, after nine years' unfruitful wedlock, gave birth to a son. In the following year, moreover, to the surprise of everyone, the King regained his reason. These two happenings finally cut away the Duke of York's prospect of succession and drove him to sudden violence.

In a word, the Wars of the Roses began.

Now this struggle had aspects other than the purely dynastic. In addition to the York princes, the great family of the Nevilles was, for example, naturally antagonistic to the reigning house, not so much because it was allied by marriage with the family of the Duke of York, as because its most bitter rival in the north of England was the Percy family, which had always been staunchly Lancastrian. To a very large extent, therefore, the Wars of the Roses were a collection of *private feuds* between those and similarly hostile families.

It is also possible to trace in them the influence of *political* and *geographical* considerations.

York and Lancaster

Ever since the time of Richard II. there had been some branches of the royal house who were opposed to the reigning branch ; and the opposition princes usually found it convenient to associate themselves with that party in the country which cried out for reform and good government. The Duke of York followed this precedent ; and, since there was a widespread discontent with the government of Henry VI. on account of its failures at home and abroad, he found himself hailed as the champion of reform, being especially popular in the towns and among the mercantile classes of the south.

The Lancastrians represented the conservative elements in the country, being closely connected with the Church, and—save for a few notable exceptions—with the great nobility. Their strength, therefore, lay mainly in the west and north, where feudalism had not yet broken down.

The course of the war is very intricate and hard to follow. Hostilities began with the *First Battle of St. Albans* (May 22, 1455). Here the Lancastrians suffered a heavy defeat, the Duke of Somerset being slain, whilst, as a condition of the subsequent truce, Richard of York was proclaimed successor to Henry VI.

In 1459 the Queen, who was endowed with something akin to a genius for war, renewed the struggle ; and the Lancastrians, after being defeated at *Bloreheath*, routed the Yorkists at *Ludford*. Parliament then passed a Bill of Attainder against the Duke of York, who was compelled to fly for his life to Ireland.

Warwick, the King-maker.

In 1460 his party again took up arms, and on July 10 defeated their opponents at *Northampton*, where Henry VI. was taken prisoner, and the Duke of York for the second time proclaimed heir to the throne. Later in the year, however, he was defeated near *Wakefield*, captured, and put to death. The Queen followed up this success by another great victory, the *Second Battle of St. Albans*, at which King Henry was rescued from his captors.

It then seemed almost certain that the Lancastrian cause would triumph. But Richard of York's son, *Edward*, continued the struggle relentlessly, and owing partly to his own military skill, partly to the machinations of the *Earl of Warwick*, known subsequently as the *King-maker*, and partly to the excesses of the Queen, contrived to have himself proclaimed King in 1461.

For some years there was no one to dispute the rule of Edward IV. ; but, unfortunately for himself, Edward quarrelled with Warwick, and the King-maker, greatly wroth at the intrigues of the King, went over to the Lancastrian party, and in 1471 helped to restore the unhappy Henry VI. to the throne. Henry's second reign endured only a few weeks. He and his party were utterly defeated at the battles of *Barnet* and *Tewkesbury* (1471), and Edward IV. was left in undisputed possession of the throne, which he held until his death in 1483.

Edward IV. was essentially a strong man, and as such held in check the various warring factors in the country. On his death, however, intrigue, jealousy and revolt again lifted their heads. The late King left behind him two sons—*Edward*, aged twelve, and

Richard, aged nine—and a daughter, *Elizabeth*. The question of the Regency, therefore, immediately became a problem of passing importance. The office was eventually secured by Richard of Gloucester, the youngest brother of Edward IV.

Now Gloucester had the makings of a really great man. But he was the slave to an overweening ambition; and once he had the boy King within his power he allowed ambition to overcome his scruples. In August 1483 Edward V. and his young brother were done secretly to death in the Tower of London; and there can be little doubt but that this foul crime was instigated by the Regent, who then calmly seized the throne, proclaiming himself *King Richard III.*

But the crown which he had usurped never lay easily on Richard's head. Conscientiously though he strove to govern well and in accordance with the law, circumstances—one may almost say, the workings of Fate—proved too strong for him. Not only was popular opinion against him from the outset, but his position was made still more difficult by a *rapprochement* between the party of the dowager Queen and the Lancastrians, who were now led by Henry of Richmond.

In 1485 the latter took up arms against the Yorkist King, and, having collected an army in France, landed in August at Milford Haven. On the 22nd of the month he met and utterly defeated Richard near *Bosworth;* then marching

From the panel by H. A. Payne, in the House of Commons.

RED ROSE OR WHITE?

Above is shown the scene in the Temple Gardens, London, when the symbols borne by the two great parties in the War of the Roses were first adopted. Richard, Duke of York (left), plucking a white rose, called on his supporters to do likewise. Thereupon, the Duke of Somerset, as champion of the house of Lancaster, gathered a red rose, urging his followers also to accept the challenge.

on London, proclaimed himself *King Henry VII.*

Thus ended the Wars of the Roses, for in the following year, by marrying Elizabeth, daughter of Edward IV., and so uniting the Houses of York and Lancaster, Henry provided the solution to a problem which thirty years of fighting had done nothing to unravel.

But, if the actual result achieved by this struggle was small, the indirect effects were of immense importance.

In the first place, the Wars of the Roses almost completely destroyed the old nobility. They thus paved the way for the absolutism of the Tudors, since the new nobility owed its rise entirely to the Crown, and was in consequence extremely servile. Secondly, the Church, which had rested for support largely on the barons, became so much weakened as to be unable to resist the Crown; whilst the people, deprived of their leaders, were glad of a government strong enough to preserve them from the horrors of another civil war.

The commercial classes and great towns had played but a small part in the Wars of the Roses, and for this reason had grown rich and prosperous.

Now it was these classes which formed the backbone of the House of Commons. Thus the influence of that House steadily increased with the rise of the towns.

Disappearance of Slavery

Slavery, moreover, and the evils by which slavery is everywhere accompanied, were fast disappearing. It is remarkable that the two greatest and most salutary social revolutions which have taken place in England, that revolution which, in the thirteenth century, put an end to the tyranny of nation over nation, and that revolution which, a few generations later, put an end to the property of man in man, were silently and imperceptibly effected. None can venture to fix the precise moment at which either distinction ceased. Some faint traces of the old Norman feeling might perhaps have been found late in the fourteenth century. Some faint traces of the institution of villenage were detected by the curious so late as the days of the Stuarts; nor has that institution ever to this hour, been abolished by statute.

It would be most unjust not to acknowledge that the chief agent in these two great deliverances was religion; and it may perhaps be doubted whether a purer religion might not have been found a less efficient agent. The benevolent spirit of the Christian morality is undoubtedly adverse to distinctions of caste. But to the Church of Rome such distinctions are peculiarly odious; for they are incompatible with other distinctions which are essential to her system. She ascribes to every priest a mysterious dignity which entitles him to the reverence of every layman; and she does not consider any man as disqualified, by reason of his nation or of his family, for the priesthood.

In our own country this peculiarity of the Roman Catholic system produced, during the middle ages, many salutary effects. It is true that, shortly after the battle of Hastings, Saxon prelates and abbots were violently deposed, and that ecclesiastical adventurers from the Continent were intruded by hundreds into lucrative benefices. Yet even then pious divines of Norman blood raised their voices against such a violation of the constitution of the Church, refused to accept mitres from the hands of William, and charged him on the peril of his soul, not to forget that the vanquished islanders were his fellow Christians.

The first protector whom the English found among the dominant caste was Archbishop Anselm.

Church and State

It was Anselm who, during the reign of Henry I., raised the very important question of *lay investiture.*

Owing to the growth of the royal power, the tenure of clerical lands had become assimilated to that of lay, with the result that the nomination of bishops, and their investiture with the emblems of their spiritual dignity, had passed almost exclusively into the hands of the King. Now Anselm declined to be "invested" by the King, insisting that the privilege claimed by the latter belonged only to the Pope; and for a long time a fierce controversy raged between the Church and the monarchy.

Eventually Henry I. and the Pope accepted a compromise. The King agreed that in future the chapters should elect their bishops, provided that the election was made in the King's Court. He also agreed to give up the investiture with ring and crozier provided that bishops should do homage for their temporalities.

In actual fact, the King, while retaining the power of appointing bishops and the rights of suzerainty over them, abandoned his encroachments on their spiritual dignity. And this was an important concession—important from the ecclesiastical point of view, and still more important from the secular point of view, in that it showed to the people of England that there existed in the country one power at any rate—namely the Church—that was strong enough to withstand the tyranny of the King.

Then, again, at a time when the English name was a reproach, and when all the civil and military dignities of the kingdom were supposed to belong exclusively to the countrymen of the Conqueror, the despised race learned, with transports of delight, that one of themselves, Nicholas Breakspear,*

* Nicholas Breakspear (Adrian IV.) became Pope in 1154 and died in 1159. He was the only Englishman who has ever been raised to the papal chair.

had been elevated to the papal throne, and held out his foot to be kissed by ambassadors sprung from the noblest houses of Normandy.

It was a national as well as a religious feeling that drew great multitudes to the shrine of Becket, whom they regarded as the enemy of their enemies. Whether he was a Norman or a Saxon may be doubted: but there is no doubt that he perished by Norman hands, and that the Saxons cherished his memory with peculiar tenderness and veneration, and, in their popular poetry, represented him as one of their own race. A successor of Becket [Stephen Langton] was foremost among the refractory magnates who obtained [from King John] that charter which secured the privileges both of the Norman barons and of the Saxon yeomanry.

How great a part the Roman Catholic ecclesiastics subsequently had in the abolition of villenage we learn from the unexceptionable testimony of Sir Thomas Smith, one of the ablest Protestant counsellors of Elizabeth. So successfully had the Church used her formidable machinery that, before the Reformation came, she had enfranchised almost all the bondmen in the kingdom except her own, who, to do her justice, seem to have been very tenderly treated.

There can be no doubt that, when these two great revolutions had been effected, our forefathers were by far the best governed people in Europe. During three hundred years the social system had been in a constant course of improvement. Under the first Plantagenets there had been barons able to bid defiance to the sovereign, and peasants degraded to the level of the swine and oxen which they tended.

The exorbitant power of the baron had been gradually reduced. The condition of the peasant had been gradually elevated. Between the aristocracy and the working people had sprung up a middle class, agricultural and commercial. There was still, it may be, more inequality than is favourable to the happiness and virtue of our species: but no man was altogether above the restraints of law; and no man was altogether below its protection.

From the picture by Paul Delaroche in the Louvre, Paris. After a photo by Messrs. Braun & Co.

THE CHILDREN OF EDWARD IV. IN THE TOWER,

where, in 1483, at the instigation of Richard of Gloucester (Edward IV.'s youngest brother), they were done to death—stifled with pillows and bolsters by two hired assassins as they lay together in the same bed.

Continued from Vol. II., page 472.

SCIENCES:

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CHEMISTRY.—XVII

Nitric Acid.—Before proceeding to the study of nitric acid, we have to consider the equations for the reactions already studied in connection with hydrogen, water, and chlorine.

Hydrogen and Water.—Action of dilute sulphuric acid on metals. (Vol. I., p. 337.)

Zinc, $Zn + H_2SO_4 = H_2 + ZnSO_4$.
Magnesium, $Mg + H_2SO_4 = H_2 + MgSO_4$.
Iron, $Fe + H_2SO_4 = H_2 + FeSO_4$.

The formulæ of the solid, crystallised sulphates of these metals all contain seven molecules of water of crystallisation (Vol. II., p. 14); e.g., the formula for zinc sulphate is written $ZnSO_4, 7H_2O$.

Combustion of hydrogen, $2H_2 + O_2 = 2H_2O$.
Heat on copper sulphate, $CuSO_4, 5H_2O = CuSO_4 + 5H_2O$.

Decomposition of water (Vol. II., p. 14).

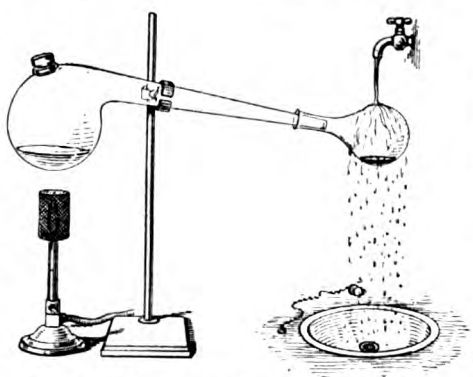


Fig. 25.—Apparatus for the Preparation of Nitric Acid.

Iron, $3Fe + 4H_2O = 4H_2 + Fe_3O_4$.
Sodium, $2Na + 2H_2O = H_2 + 2NaOH$.
Potassium, $2K + 2H_2O = H_2 + 2KOH$.
Electrolysis, $2H_2O = 2H_2 + O_2$.

Hydrogen and heated oxides (Vol. II., p. 66).

$CuO + H_2 = H_2O + Cu$.
$Cu_2O + H_2 = H_2O + 2Cu$.
$PbO + H_2 = H_2O + Pb$.
$Fe_3O_4 + 4H_2 = 4H_2O + 3Fe$.

Hydrogen chloride (Vol. II., p. 136).

Preparation: $NaCl + H_2SO_4 = HCl + NaHSO_4$.
Action on iron: $Fe + 2HCl = H_2 + FeCl_2$.
Action on oxides: $CuO + 2HCl = H_2O + CuCl_2$.
$PbO + 2HCl = H_2O + PbCl_2$.

Composition by volume (Experiment XL.).
$2Na + 2HCl = H_2 + 2NaCl$.
Composition by weight (Experiment XLI.).
$Zn + 2HCl = H_2 + ZnCl_2$.

Chlorine (Vol. II., p. 196).

Preparation, $MnO_2 + 4HCl = 2H_2O + MnCl_2 + Cl_2$.
Union with hydrogen, $H_2 + Cl_2 = 2HCl$.
Reaction with turpentine is represented as follows:—$C_{10}H_{16} + 8Cl_2 = 16HCl + 10C$.
Copper, $Cu + Cl_2 = CuCl_2$
Sodium, $2Na + Cl_2 = 2NaCl$.
Phosphorus, $2P + 5Cl_2 = 2PCl_5$.
Decomposition of chlorine water by sunlight,
$2Cl_2 + 4H_2O = 4HCl + O_2$.

Precipitation of copper by zinc (Experiment XLV.).

$CuSO_4 + Zn = Cu + ZnSO_4$.

Nitric acid, one of the longest known and most useful of acids, derives its name from the fact that it was made from nitre. This substance, also known as saltpetre and potassium nitrate, is composed of potassium, nitrogen, and oxygen, its composition being given by the formula KNO_3; when it, or the cheaper sodium nitrate $NaNO_3$, is warmed with sulphuric acid, nitric acid is evolved as a vapour, which is easily condensed to a fuming, corrosive liquid—nitric acid, HNO_3. The reaction which occurs when the materials are heated together to about 130° C. is: $NaNO_3 + H_2SO_4 = HNO_3 + KHSO_4$. If a higher temperature be employed, the same weight of sulphuric acid decomposes twice the weight of nitrate: $2NaNO_3 + H_2SO_4 = 2HNO_3 + Na_2SO_4$. In this case

normal sodium sulphate, Na_2SO_4, is formed instead of the acid or hydrogen sulphate $NaHSO_4$ (sometimes called sodium bisulphate), but the economy is not so great as would appear, because at the higher temperature a considerable amount of the nitric acid is decomposed.

Experiment L (a).—*The preparation of nitric acid.*

The preparation should be carried out in a tubulated retort, clamped to a retort-stand, and the neck is passed into a small flask which is cooled by means of a wet cloth or by a jet of water. Sodium nitrate is put into the retort (about 20 grams) and sufficient oil of vitriol to cover it is poured in through the tubulure by means of a funnel. The retort is then gently heated over a protected flame, and the slightly discoloured nitric acid collects in the cooled receiver. Unless the materials used were completely free from water, the acid will contain that compound. The water and some other impurities could be eliminated by distilling the crude acid with pure sulphuric acid, and passing a current of air or carbon dioxide through the distillate.

On the industrial scale, the same materials are heated in a cast-iron retort by the hot gases from a fire circulating round it. The vapour is condensed in cooled earthenware pipes and the liquid collected in jars of the same material. The coloured gases which would escape from the last jar are collected by passing them up a tower filled with coke down which water percolates. To empty the retort, the liquid contents are run off through an exit pipe situated near the bottom. "Fuming" nitric acid is a very concentrated acid containing much dissolved gas, which gives it a dark yellow colour. Pure nitric acid is a colourless, fuming liquid of spec. grav. 1·56, and of boiling point 86°. The acid in ordinary use in the laboratory contains water and has a spec. grav. of 1·42; it mixes with water in all proportions and evolves heat. Heated or exposed to light, it undergoes decomposition, yielding water, oxygen, and nitrogen peroxide (NO_2). $4HNO_3 = 2H_2O + O_2 + 4NO_2$. The pure acid contains over 75 per cent. of oxygen, much of which it readily gives up to oxidise other substances: hence it is a strong oxidising agent, and one of the best and most frequently used in chemical practice:—

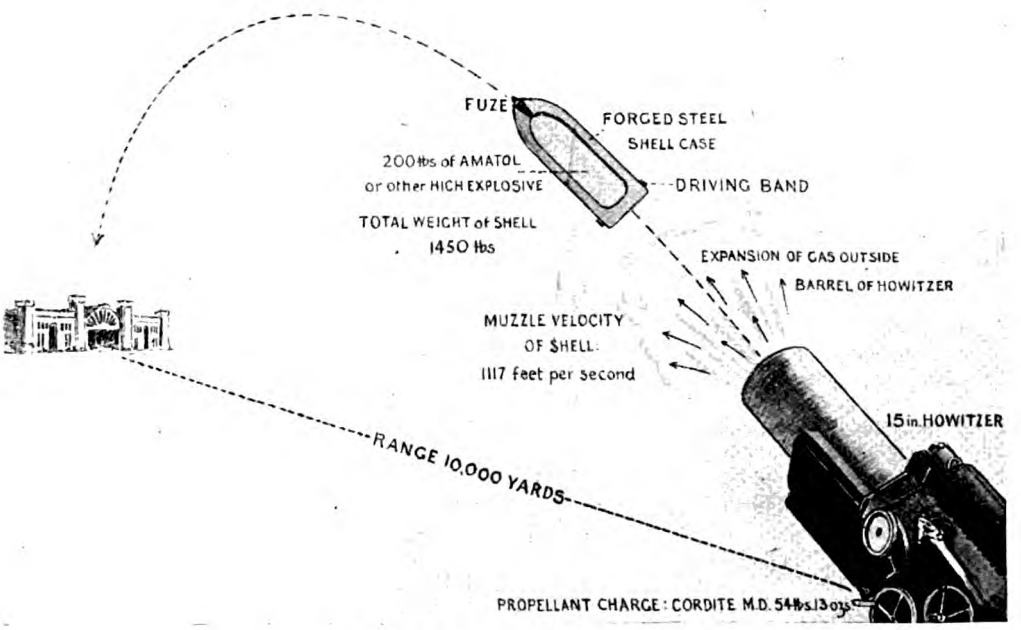
Experiment L (b).—*The properties of nitric acid.*

(i) Some sawdust is charred by heating it between two sand-baths on a tripod-stand. On pouring some concentrated acid on to the warm mass, combustion ensues. The wood burns at the expense of the oxygen of the acid, and the red fumes evolved consist of oxides of nitrogen.

(ii) Cotton-wool is turned yellow by nitric acid, and many other organic substances are similarly changed. The human skin is also attacked and turned yellow.

(iii) A solution of indigo-sulphate is bleached.

(iv) Copper turnings are placed in a dish, a little water is added, and then some acid. A violent effervescence is observed, the metal dissolves, forming a greenish-blue solution of copper nitrate, and coloured gases are evolved.



MODERN ARTILLERY

depends for its efficacy largely upon nitric acid. Nitro-cellulose (gun cotton), nitro-glycerine, lyddite, and tri-nitro-toluol (T.N.T.) are the explosives which result when cotton, glycerine, phenol, and toluol are washed with a mixture of nitric and sulphuric acids, and dried. Above is illustrated the action of a heavy howitzer.

Most metals are attacked and dissolved by nitric acid, being converted into nitrates which dissolve in water. The actions which take place are complex, the course of the reaction depending upon the nature of the metal, the concentration of the acid, and the temperature. It should be remarked that hydrogen is not evolved when nitric acid attacks metals, for the reason that it is converted into water by the oxidising action of the acid. Magnesium forms an exception to this statement, for it dissolves in very dilute nitric acid, yielding hydrogen and other gases. Tin is converted into a hydrated oxide, which, being insoluble, separates from the liquid as a white amorphous powder.

Uses.—In addition to its use as an oxidising agent, nitric acid is a very valuable solvent, particularly for metals. Gold and platinum are not dissolved by it, hence its application for "parting" gold from silver in the noble metal industry. Silver nitrate, made by dissolving silver in nitric acid of suitable concentration, is a very heavy, white, crystalline solid, which is used for photographic and medicinal preparations, in silver-plating, for marking-ink, and as a caustic in surgery. Other nitrates are used in the arts and industries, e.g., lead nitrate in calico printing, barium and strontium nitrates in the manufacture of fireworks. Nitric acid is used for etching copper, and in the manufacture of sulphuric acid, and of high explosives. Cotton, glycerine, phenol, toluol, are treated with a mixture of nitric and sulphuric acids, washed, and carefully dried. The resulting explosives are known as nitro-cellulose (gun-cotton), nitro-glycerine, melinite or lyddite, and tri-nitro-toluol (T.N.T.) respectively; when such preparations are subjected to shock, they burn with extreme rapidity, and the sudden liberation of large quantities of heated gases causes the explosion.

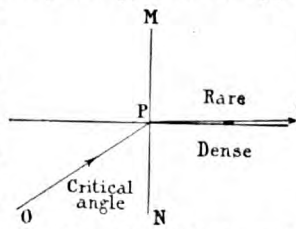


Fig. 40.—Showing the angle of refraction = 90°.

Aqua regia is made by mixing nitric and hydrochloric acids in the proportion of 1 to 3 or 4. It is used for dissolving gold, platinum, and other "noble" metals. The actions which occur are not known with certainty, but the metal always goes into solution as the chloride.

Oxides of Nitrogen. — Although nitrogen is a very inert element, nevertheless it forms many compounds with other elements, and among the more important of these are the oxides of nitrogen. The formulæ, names, etc., of these are given below:—

N_2O_5 ..	Nitrogen pentoxide or nitric anhydride. White solid.
N_2O_4 NO_2	Nitrogen peroxide. Yellow-brown gas.
N_2O_3 ..	Nitrogen trioxide or nitrous anhydride. Blue liquid.
NO ..	Nitric oxide. Colourless gas.
N_2O ..	Nitrous oxide or laughing gas. Colourless gas.

The existence of these compounds affords an excellent illustration of the Law of Multiple Proportions, for if their composition be expressed in parts by weight of oxygen united to a fixed weight of nitrogen, the weights of oxygen are found to be in the ratio of 5 : 4 : 3 : 2 : 1.

Nitrogen pentoxide N_2O_5 is made from nitric acid by distilling it with phosphoric oxide (P_2O_5); it forms white crystals of nitrogen pentoxide, which melt at 30° and boil at 47°. The phosphoric oxide acts by withdrawing the elements of water from the acid: $2HNO_3 - H_2O = N_2O_5$. The most important fact concerning this oxide is that it combines with water to form nitric acid. $N_2O_5 + H_2O = 2HNO_3$. E. H. T.

LIGHT.—V

14. Total Reflexion.—When light is incident on water or glass from air, only a little is reflected and most of it refracted in all cases. In the opposite case, however—when light passes from water or glass into air—this does not always happen. Sometimes there is both refraction and reflexion; but under certain conditions only reflexion takes place, and none of the light passes out into the air. For in this case, the angle of incidence is smaller than the angle of refraction; there comes a point when the angle of refraction is 90°, and the light merely skims along the surface and does not escape into the air. The angle of incidence, O P N (Fig. 40), which corresponds to the angle of refraction M P Q (= 90°), is spoken of as the *critical angle*.

The magnitude of this angle can be calculated as follows, taking the case of water-air, whose refractive index is $\frac{3}{4}$:—

$\frac{\sin i}{\sin r} = \frac{3}{4}$. But $\sin r = \sin 90° = 1$. $\therefore \sin i = \frac{3}{4}$.

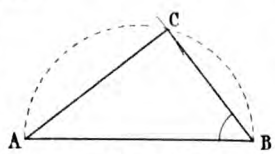


Fig. 41.—Finding an angle from its sine—without the use of trigonometry.

Hence i, which in this case is the critical angle, is the angle whose sine is $\frac{3}{4}$. From the tables this is found to be a little greater than 48°.

Those who do not know trigonometry can obtain the angle 48° from its sine in this way: Mark off a straight line A B, 4 in. long. On A B, describe a semicircle. With centre A and radius 3 in. draw an arc, cutting the semicircle at C. Join A C, B C. Then the angle A C B is a right angle, and $\sin A B C = \frac{A C}{A B} = \frac{3}{4}$. Measure the angle A B C with a protractor: it is 48° approx. (Fig. 41).

If the angle of incidence in this case is greater than 48°, there will be no refraction into the air; all the light will be reflected back into the water according to the law of reflexion. This phenomenon of *total reflexion*, as it is called, can only be observed when light passes from a denser medium into one which is less dense.

In order to show total reflexion, take a shallow glass bowl half full of water, and at one end of it place a conspicuous object A (Fig. 42). Mount

the bowl on a stand so that the eye may look obliquely through the water from the opposite side. An image of A can then be seen apparently out of the water; the surface of the water-air acts, in fact, like a good plane mirror. O is merely a strip of metal to cut off the direct view of A from the eye.

Arrange a glass prism, one of whose angles is a right angle, so that the light falls vertically as A B on the smallest side (Fig. 43). The light enters the prism without refraction, and strikes the opposite face at C, and the angle of incidence is greater than the critical angle (41°). Hence the light will be reflected along C D, and a virtual image of A will be seen in the direction of D C produced.

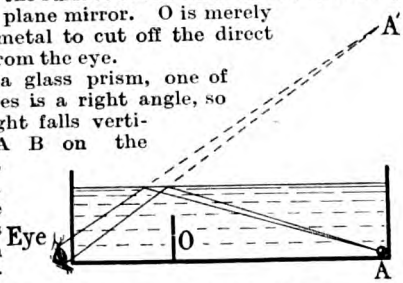


Fig. 42.—To explain the phenomenon of total reflexion.

Glass blocks in the form of rectangular triangular prisms are often used for reflecting the light of the sky into basements. They should be arranged with their shortest faces upwards; if not, the light will not be reflected downwards, even if it is totally reflected at all.

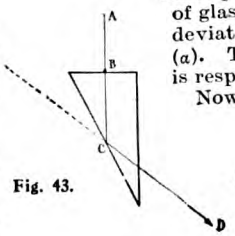


Fig. 43.

If a glass of water be held above a light and viewed obliquely from below, the upper surface will be seen to be brilliantly bright through total reflexion. The lustre of a diamond is also largely due to the same phenomenon; the refractive index of the diamond is large, and the critical angle small (about 24°); consequently most of the light that enters the diamond is totally reflected from its faces.

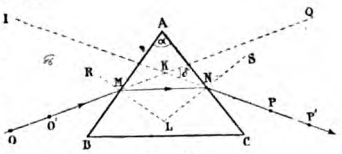


Fig 44.

15. Refraction through Prisms.—In optics we always think of a triangular prism when we speak of that figure, and we must always be understood to do so in these lessons. In order to show the course of light through a prism we proceed as follows:

Place the prism on a sheet of paper and draw its outline A B C. Place two pins O O^1 on one side of the prism: we thus fix a ray of light, O O^1, striking the prism at M. On looking through the face A C, an image of O will be seen out at I. Place the pins P P^1 in the paper so that I P P^1 seems to be a straight line. Then the straight line N P represents the course of ray O M after emergence from the prism; and M N represents its course through the prism (Fig. 44).

If in this experiment the prism be moved slightly, P P^1 will also have to be moved, to correspond to the new position of I. Now the angle Q K P, i.e. the angle between the direction of the incident and that of the emergent ray, is known as the *angle of deviation* of the ray, and obviously this varies with the position of the prism. Now, there is a certain position of the prism when this angle is a minimum, and this can be found by observing the effect of a slight movement of the prism on I. If this movement causes I to move nearer to O, then we had not the position of minimum deviation. We have therefore so to adjust the prism that a very slight change in either direction causes I to move away from O.

Find the position of minimum deviation for a given ray of light. Draw the course of the ray O M N P, and observe that in the position of minimum deviation the ray emerges from the prism at the same angle as it entered; i.e. angle O M B = angle C N P. Hence the angle of incidence, R M O, on entering the glass = the angle of refraction, S N P, on emergence. Consequently the angle of refraction, L M N, on entering the glass = the angle of incidence, L N M, on emerging into the air.

These points enable us to find the refractive index of glass by measuring (1) the angle of minimum deviation (δ), and (2) the angle of the prism (α). This latter angle is the angle at A, which is responsible for the deviation.

Now, $\alpha = 180° - \angle$ M L N.

$= \angle$ L M N + $\angle$ L N M.

$= 2r$.

$\therefore r = \frac{\alpha}{2}$.

Also, $\delta = \angle$ K M N + $\angle$ K N M.

$= (i - r) + (i - r)$.

$= 2i - 2r$.

$\therefore 2i = \delta + 2r = \delta + \alpha$.

$\therefore i = \frac{\delta + \alpha}{2}$

$\therefore \mu = \frac{\sin i}{\sin r} = \frac{\sin \frac{\delta + \alpha}{2}}{\sin \frac{\alpha}{2}}$.

The accurate measurement of these angles δ and α demands special precautions, and is best done on a spectrometer. But it is very instructive to the student to measure the angles, and hence the refractive index of the glass, in the way we have described.

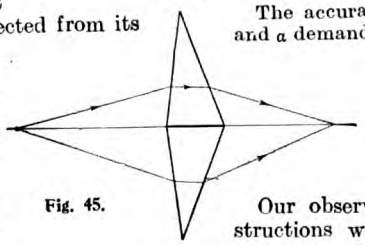


Fig. 45.

Our observations, and the geometrical constructions which follow from them, make it clear that an object viewed through a prism is apparently displaced towards the refracting angle of the prism; in other words, the light is refracted and its direction deviated towards the base of the prism. Suppose then two equal prisms are placed base to base as in Fig. 45. Clearly, rays of light diverging from a point on the common base produced will be rendered less divergent by the double prism, and may even converge to form a real image on the other side of it, as shown in the figure. And conversely—if the prisms are placed symmetrically apex to apex, as in Fig. 46, the light will become more divergent and a virtual

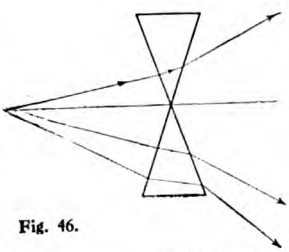


Fig. 46.

image will be formed, as shown. This gives us the clue to the behaviour of lenses, which may be thought of as double prisms of this kind.

16. Lenses—General Behaviour.—A *lens* is a piece of glass bounded by two surfaces, usually spherical, though one of them may be plane. If the lens is thickest at the middle, it is called *convex*; if thinnest at the middle, it is called *concave*. The convex lens is analogous in its behaviour to the double prism with the bases in contact, and its effect is always to make light less divergent. On the other hand, the concave lens behaves like the prisms of Fig. 46, and always makes the light more divergent, producing consequently only virtual images.

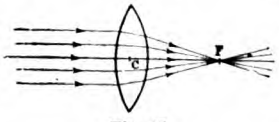


Fig. 47.

Lenses in common use are generally very thin, so that the colour phenomena associated with prisms are reduced to a minimum, and the caustic curves equally avoided. For the student's experiments ordinary spectacle lenses will answer quite well.

Within a lens there is a certain point, known as the *centre of the lens*, such that, if a ray of light during refraction passes through it, it emerges parallel to its original direction; when the lens is very thin, such a ray may be said to pass through it undeviated. The *axis of the lens* is a straight line drawn through the centre of the lens so as to divide the lines symmetrically.

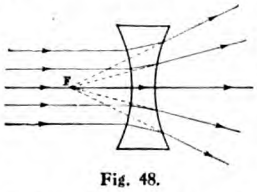


Fig. 48.

Take now a convex lens, and hold it between the fingers so that the light from some distant object falls upon it. The light passes through the lens and converges to a real image which can be collected on a screen. The image is very small and intense; if sunlight is used, the image is hot enough sometimes to set paper alight or to burn the skin, showing that the sun's heat comes to the same focus as its light.

This point, to which parallel rays are brought, is the *principal focus*, and its distance from the lens is called the *focal length* of the lens.

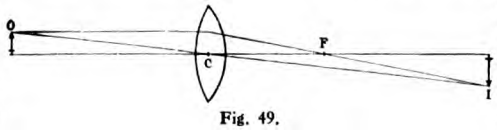


Fig. 49.

In order to get the most exact image, the light must fall evenly on the lens, so that the axis represents one of the rays. Otherwise a good and exact focus cannot be obtained, because—even with a thin lens—all the rays are not brought to the same focus when the parallel rays fall on the lens obliquely.

Repeat this process with a concave lens. No real image of the sun can be collected on the screen—only a patch of light which becomes smaller as the lens is brought near to the screen, but never condenses into a real image. Hold up the lens between the eye and any distant object (not the sun, which is too bright); a virtual image will be observed which is smaller than the object and apparently nearer. The parallel rays have been made divergent, and to an observer they now appear to diverge from a point behind the lens, where the virtual image appears to be. Thus the principle focus of a concave lens is virtual (Fig. 48).

Further experiments with a concave lens will show that the image is always of this same character—virtual, erect, diminished in size. Thus a person who wears concave spectacles sees objects nearer and smaller than a person with normal sight. He is "short-sighted"; and his spectacles enable him to see distant objects, out of his range otherwise, by bringing them to all intents and purposes nearer to him.

Continuing the observations with a convex lens, we find that usually the image obtained is real, inverted, and of varying size (Fig. 49): the image is smaller than the object when it is nearer to the lens, and vice versa. When the object is placed at the principal focus, no image can be obtained at all; when it is nearer to the lens than this point, the image cannot be collected—it can be seen by looking through the lens to be erect, virtual, and magnified.

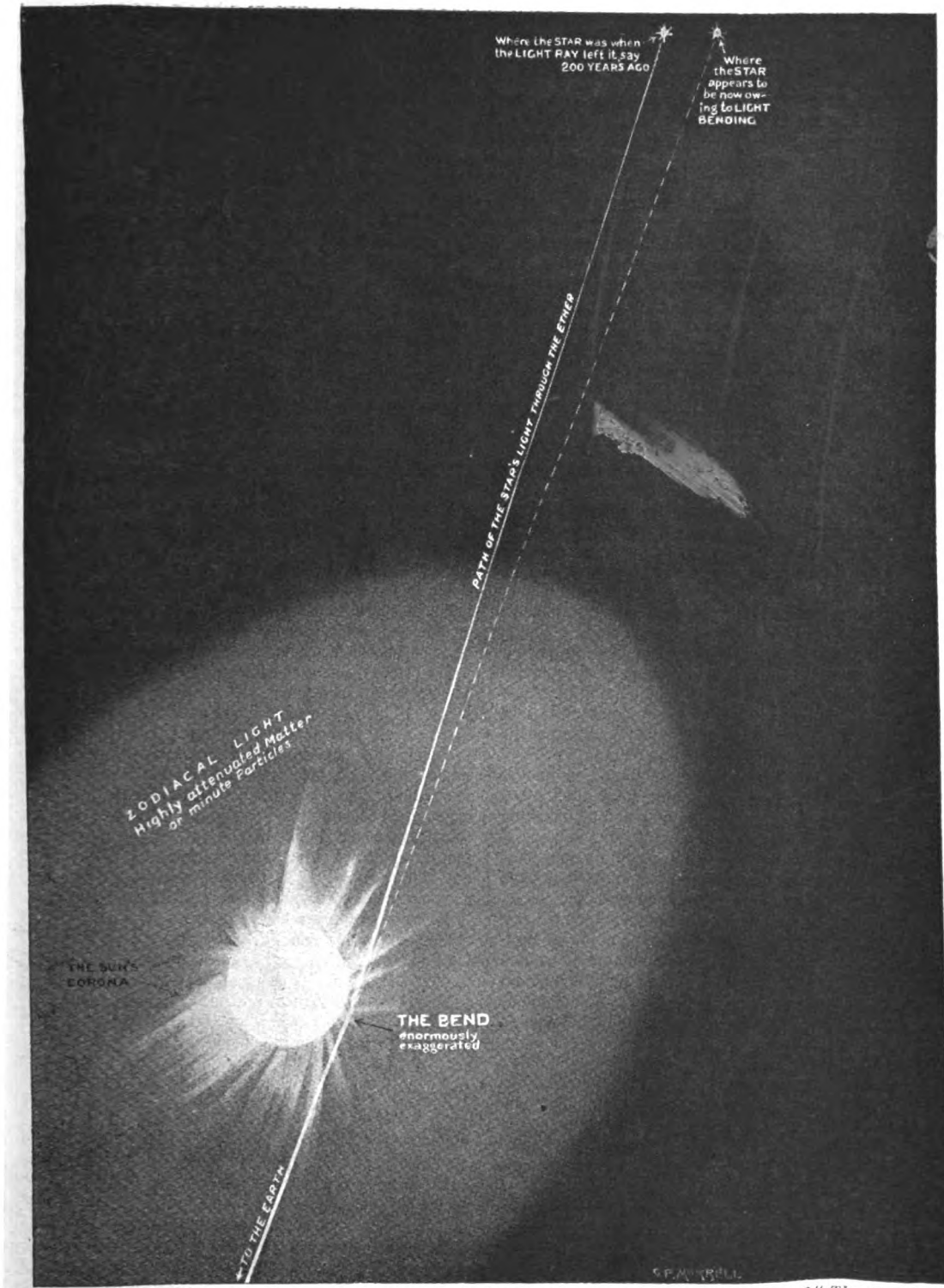
Thus the effect of a convex lens is always to diminish the divergence of a pencil of rays. If they start from a point beyond the principal focus, the divergent rays are made convergent; starting from that point itself, they are made parallel; starting from a nearer point they are made less divergent, so that they appear to come from a more distant point. This latter effect explains the use of convex spectacles to "long-sighted" persons; they make very near objects seem more distant, and hence visible, by the defective eye, which cannot adjust itself to near objects. The fact that the virtual image formed is magnified explains the use of a convex lens as a magnifying glass for reading and other purposes.

Experiments with lenses are best done in a darkened room. The student should take care that the candle or other luminous object is on the axis of the lens, and that the screen is not placed obliquely. Arrangements should be made for fixing all the apparatus when measurements are to be made. A suitable lens-holder can be bought cheaply from dealers in scientific apparatus.

The uses of lenses are very numerous, apart from their value in correcting the eyesight. The action of a lens in a camera is that of a simple convex lens throwing a real inverted image on a screen: telescopes and microscopes are essentially combinations of lenses, in which the real image formed by one lens is viewed by another.

Some additional remarks regarding the general behaviour of lenses will be found in the next lesson of this course. The question of lenses, apart from its interest, is of great importance and deserves careful study.

E. W. E.



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Dr. Albert Einstein's theory that rays of light are deflected as they pass through the gravitational field of the sun, was confirmed by observations of the solar eclipse of May, 1919. The diagram, of course, is not in true proportion. If the earth be considered a foot from the sun, the star must be considered 2,400 miles away!

ELECTRICITY AND MAGNETISM.—V

Magnetic Force and Measurement.—In previous lessons frequent use has been made of the term "magnetic force." Force is that which tends to produce motion, and magnetic substances will certainly move under the influence of magnetic force if there are no obstacles or forces to prevent their doing so. Let us consider the case of two bar magnets lying on a table with the north pole of the one near the south pole of the other. A force of attraction exists between these two opposite poles, yet the magnets do not move towards each other, because they are prevented from doing so by gravitation, friction, and a property known as inertia. In this case gravitation is the force tending to pull the magnets towards the centre of the earth, and causing friction between them and the table.

Inertia is the tendency of a body to continue to be at rest if it is motionless, or to go on moving if it is not at rest.

The two magnets considered do not move, but the force is there all the same, though it is insufficient to produce motion, as in the case of a small boy tugging at a heavy garden roller which he is unable to move.

When a small needle jumps to the pole or magnet, the magnetic force of attraction overcomes gravity, inertia, and friction. The friction in this case exists between the needle and air particles which very feebly oppose its movement to the magnet. The needle being small and light, its inertia and weight (gravity) are not sufficient to balance the magnetic force of attraction.

The student will have realised that the needle became magnetised under the inductive influence of the larger magnet, and it must be carefully noted that there can be no magnetic force, either of attraction or of repulsion, in the case of one magnet and an unmagnetised substance. It is obvious that magnetic force can exist only between magnets, of which there must be at least two. In the case of a single magnet lying on a table there is a directive force due to the magnet and the earth's magnetism. Although one magnet may be very much larger than another, each contributes its strength to the resulting force of attraction or repulsion as the case may be.

When there are two magnets, one of which derives its magnetism from the inductive influence of the other, the force is one of attraction, but when two or more permanent steel magnets come within one another's fields the resultant force may be one of attraction or repulsion according to the arrangement of the magnets' poles.

Means of comparing and measuring magnetic forces will have suggested themselves to the student. They may be balanced against gravitation, inertia or the earth's directive force.

We may compare roughly the strength of two or more magnets by noting what weights they will support respectively, in which case we should be balancing magnetic force against gravitation. But that is not the usual method, since accurate results are obtained by balancing the magnetic forces against the directive force of the earth's magnetism, the experiment being performed by means of an apparatus called a Magnetometer, and in some forms of this instrument inertia has to be taken into consideration.

Pole Strength and Distance.—Before considering the use of a magnetometer let us perform a very simple experiment, which will enable us to draw very important conclusions.

Experiment 17.—*To investigate pole strength and distance in relation to magnetic force.*

Slowly bring one pole of a bar magnet vertically downwards towards a small needle and note the distance at which the needle jumps to the magnet. Try the experiment with another magnet considerably weaker than the first, and again note the distance across which the needle jumps. In the second case the distance is less than in the first case.

The experiment seems extremely simple, but there is more in it than there appears to be. The needle jumps to either magnet when the magnetic force is sufficient to overcome the weight and inertia of the needle. Since these are the same when either magnet is used, it follows that the magnetic force is the same with either magnet *at the moment when the needle jumps.* But the distances across which the jump occurs are different in the two cases. From these facts we deduce that the magnetic force varies according to the pole strength of the magnets used, and with the distance between them. The relation between distance and magnetic force is an *inverse* one, the greater the distance between the two magnets the less the resulting force. Further, this relation is not a simple one, for magnets separated by a distance of one inch exert a force not twice, but *four* times as great as that due to the same magnets when placed two inches apart. Placed three inches apart the resultant force is only $\frac{1}{9}$th of that when the magnets are separated by a space of one inch, and so on.

These facts may be expressed by saying that *the magnetic force varies directly with the pole strength, but inversely with the square of the distance.* Adopting symbols we can express this relation between pole-strength, distance, and magnetic force by the formula

$$F = \frac{p_1 \times p_2}{d^2}$$

Where F = the resultant force.
p_1 = the pole strength of one magnet.
p_2 = the pole strength of the other magnet.
d^2 = the square of the distance.

If actual measurements are to be made, then units must be employed. In scientific calculations the unit of length is the centimetre, hence d^2 will be expressed in centimetres. Force is measured in units called dynes, but the unit of pole strength is not so simple. A magnetic pole the strength of which is such that it repels another like pole of exactly equal strength with a force of one dyne when the two poles are placed one centimetre apart, is called the unit pole. In calculations it is usual for the student to be told how many units of

pole strength a magnet has. Thus, calculate the magnetic force when a north pole of five units is placed 2 centimetres from a south pole of 4 units.

We have seen by the formula that we must multiply the pole strengths and divide by the square of the distance.

The calculation is $F = \frac{5 \times 4}{2^2} = \frac{20}{4} = 5$

Therefore the resultant force of attraction is 5 dynes. If both poles were of the same polarity the force would still be 5 dynes but it would be one of repulsion.

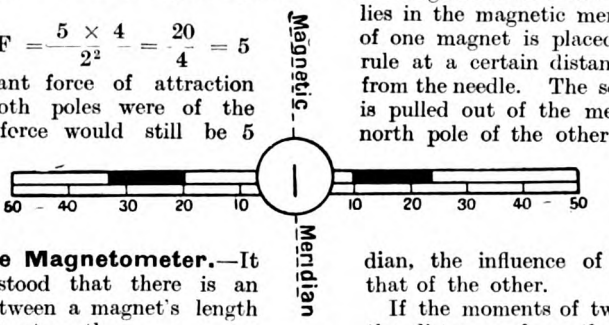


Fig. 17.

Moment and the Magnetometer.—It will easily be understood that there is an important relation between a magnet's length and its total magnetic strength.

Other things being equal, a long magnet should possess more magnetism than a short one, hence in comparing the total magnetic strength of magnets we must take their lengths into account. *The product of multiplying the pole strength of a magnet by the distance between its two poles is called the Moment of the Magnet.*

Many experiments and calculations can be made by means of a magnetometer but they involve a knowledge of trigonometry, and for the present it will suffice if we note the general method of using these instruments without the aid of mathematics, beyond the scope of our present studies.

The Declination Magnetometer consists of a short magnetic needle mounted freely on a pivot so that it sets itself in the magnetic meridian, when undisturbed by other magnetic substances.

A metre rule, with a groove in it for sliding magnets to or from the magnetometer needle, is arranged in a direction *at right angles to the magnetic meridian.* A half of the graduated rule is on either side of the needle.

The earth's magnetism tends to hold the magnetometer needle in the meridian, but a magnet in the groove along the metre rule tends to pull it out of the meridian; the consequence is that the needle comes to rest at a certain angle with the meridian when the earth's directive force is balanced by the attracting force of the magnet.

The metre rule is graduated from the centre of the pivot supporting the magnetometer needle, and the exact distance of the centre of a magnet in the groove can be noted. Now suppose we wish to compare the moments of two magnets.

The magnetometer is arranged so that the needle lies in the magnetic meridian. The north pole of one magnet is placed along the graduated rule at a certain distance, say 20 centimetres from the needle. The south pole of the needle is pulled out of the meridian. Now if the north pole of the other magnet is adjusted in the groove of the scale on the other side until the needle again lies in the meridian, the influence of one magnet balances that of the other.

If the moments of two magnets are unequal the distances from the magnetometer centre will be different, and the moments of the magnets will be proportional to the *cubes* of their respective distances measured from the centre of each magnet.

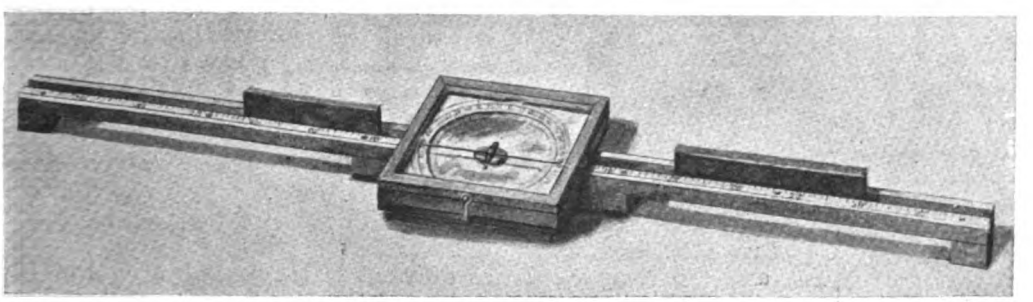
The distance of the first magnet's centre is $27\frac{1}{2}$ centimetres, and we will suppose that the distance of the second is $17\frac{1}{2}$ centimetres (*see* Fig. 17).

The cube of $27\frac{1}{2}$ is $(27\frac{1}{2} \times 27\frac{1}{2} \times 27\frac{1}{2}) = 20797$, and that of $17\frac{1}{2}$ is $(17\frac{1}{2} \times 17\frac{1}{2} \times 17\frac{1}{2}) = 5359$. Therefore the moment of the first magnet is nearly four times that of the second.

Moment must be carefully distinguished from pole strength, and in comparing the moments of magnets, the distances between the magnets' centres and the magnetometer centre must be cubed, not squared as in the case of measuring the magnetic force due to two poles placed at a certain distance apart.

In declination magnetometers the magnet is always short, in order that its poles shall be under the influence of the magnets whose moments are being compared, and if a small compass is used, a rough but useful magnetometer may be constructed. The student should procure a piece of thick cardboard or thin smooth wood about a yard long and from two to three inches in width. One edge should be parallel with that on the opposite side.

By measuring with a foot rule, tape measure, or a piece of string find a point half the distance of



THE DECLINATION MAGNETOMETER.

Used for comparing the moments of two magnets. Note the short needle and long non-magnetic pointer.

the length, and through this point make a pencil line straight across the width of the board and at right angles to the longer edges. Place the compass on this line, and adjust the board so that the compass needle lies directly above the line when it is at rest in the magnetic meridian. Draw a circle on the board and around the compass in order to know where to place it each time the apparatus is used.

For *comparing* moments we do not need to know the angle of deflection since the magnets are adjusted until the needle is back in the meridian, but a scale of distance is necessary. Through the point immediately under the supporting pivot of the compass rule a straight line down the entire length of the board. This line should be midway between the longer edges and parallel with them. Mark off on the line two scales of centimetres, starting at the point under the compass pivot and proceeding to each end of the board. A centimetre ruler may be obtained at a stationer's for three or four pence.

To use the instrument, place the compass on the circle and see that the scale on the board is at right angles to the needle when it is in the meridian before putting any magnets upon the scale.

L. M. P.

ZOOLOGY.—XV

THE Tit or Titmouse is to be found in all parts of the world excepting South America and Australia. He is a noisy little bird, with plumage often gaily coloured, and lives chiefly upon insects. The Tits are represented in Britain by the Blue Tit, the Great Tit, the Coal Tit, the Marsh Tit, the Crested Tit, and the Long-tailed Tit.

Tits and Wrens

The Tits nest usually in the hollows of trees or in crevices in walls, but like the Robin, they are known on occasion to make use of the most unexpected places. Mr. Ernest Protheroe records the interesting fact that two Green Tits were found in 1890 to have nested in the village letter-box at Rowfant. "Although," he continues, "the box was in constant use, letters frequently lying on the sitting bird's back, she exhibited no concern, nor did she leave the nest, even when the box was cleared."

The Blue Tit, which is perhaps the best known of the British Titmice, though a smaller bird than the Great Tit, is somewhat pugnacious for his size, which rarely exceeds 4½ in. in length. The Great Tit has an unfortunate reputation for eating the brains of his lesser brethren. It is more than probable, however, that this unwholesome tendency is peculiar to individuals rather than characteristic of the tribe.

The Coal Tit owes his name in part to his black head and throat, which is clearly to be distinguished against white on the cheeks, and at the juncture of the neck and back. The Marsh Tit, blacker and lacking the white relief, will usually be found in the vicinity of marshes and swamps, while the Crested Tit nests in groves of firs or oaks. The Long-tailed Tit, sometimes called Bottle Tit, is less frequent in Britain than other Titmice. Though he has but a small body his length exceeds five inches.

The Common Nuthatch, to be met with in the South of England, has a slate blue back and a cinnamon chest. A member of the Creeper family, he feeds chiefly upon insects which, by the aid of his wedge-shaped bill, he digs from the bark of trees.

The Common Tree Creeper, a smaller bird than the Nuthatch, has similar habits. His plumage is brown marked with white and black, and his bill, which is less powerful than that of his relative, is curved.

The Wren, at one time a much persecuted little bird, has as its best known representative in Britain the Gold-crested Wren. It is one of the most brilliantly coloured of British birds. The Fire-crested Wren is a larger bird not so often seen in Britain.

Finches

The Finches, like the Tits, are a widely distributed family, different species being found in all parts of the world. Amongst the members of this family we have birds as different in temperament as the House Sparrow and the Goldfinch, and all the variety in song to be found between the notes of the Bullfinch and those of the Canary. Caterpillars and other insects, varied by a diet of buds, form the staple food of this family.

The Chaffinch is one of the Finches most frequently to be seen in England. He is a pretty singer, and presents a most attractive appearance owing to his varied and gaily coloured feathers.

The Goldfinch, a delightful songster, is a smaller and more brilliantly coloured bird than the Chaffinch. The Greenfinch, sometimes known as the Green Linnet, frequents gardens and cultivated lands. When captured he frequently develops a very pleasing song, and soon becomes comparatively tame. The Hawfinch or Black-throated Grosbeak is a shy bird somewhat plentiful in many parts of England but rare elsewhere in the British Isles. The Bullfinch is a bird more appreciated in captivity, when he becomes a very sociable pet, than

JACKDAW.
The smallest member of the Crow family.

JAY.
Possesses great powers of mimicry.

CARRION CROW.
As formidable an enemy to the farmer as the Raven.

ROOK.
Distinguishable from the Crow by the absence of feathers from the lower part of the bill.

MEMBERS OF THE CROW FAMILY.

Photos : Peter Webster, Newcastle-on-Tyne.

in a wild state, when he is destructive to fruit blossoms and fruit bushes.

The Canary is probably the favourite cage bird throughout the world. In a wild state his note is less varied, and his appearance frequently less vivid than in captivity. He is common to Africa, though he migrates to Central Europe in the summer.

The House Sparrow is a hardy little fellow who in towns and cities picks up a living with an industry and perseverance that is entirely praiseworthy. In the country, however, he does grave damage by feeding on seeds and the shoots of young plants. For this reason he is generally hunted by the farmer, who is seldom influenced in his favour by the plea that he accounts for many destructive insects. The Sparrow's nest is at the best of somewhat fortuitous construction, consisting as it does largely of whatever appropriate material is nearest to hand. The Sparrow, however, is not lacking in ability to appreciate a higher form of nest-building art, and on occasion he does not scruple to exhibit his preference for it by "commandeering" the nest of a Martin or a Swallow.

Linnets and Crossbills

The Tree Sparrow, a lighter coloured bird, is not found in towns. He builds in crevices in walls and cliffs, and in trees.

The Linnet is somewhat peculiarly coloured since in winter the red feathers of the head and breast take on a brown tint. This habit gave rise to the supposition that there were in effect both red and brown Linnets. Actually, however, the species is the same.

The Crossbill has secured his name from the form of his bill, the two halves of which cross at the tip, and thus form an effective weapon with which this bird can attack the pine cones. By levering up the scales of the cone he is able to scoop out the seeds with his tongue.

The Buntings, a numerous family, for the most part natives of the northern parts of the eastern hemisphere, generally possess a palate knob which is used for crushing seed.

The Weaver Bird, though not met with in Britain, is well known by repute since the skill with which he constructs his bottle-necked nest never fails to interest the ornithologist. To see this bird in his wild state it is necessary to visit India, Africa, or Australia. The grass with which the Indian birds make their nest is very cleverly interwoven, one bird working from inside the nest, and the other from outside.

The Sociable Weaver of South Africa may claim to be a stage farther along the road of mental development since he enjoys what is virtually a form of communal life. Great numbers of these birds unite to construct on a chosen tree a large grass roof which is sloped after the fashion of the thatched roofs still to be seen on country cottages. Beneath this wide shelter the birds build their nests.

The Skylark is a member of a large family of which, however, only two members are to be encountered in Britain. Elsewhere in Europe and in Africa the Larks are abundant. As a songster the Skylark has attained great fame, though it is, or should be, an open question whether the fascination of his song has not been greatly exaggerated. The song is commenced when the bird is a few feet above the ground, and is continued as he mounts and subsequently from a great height. In captivity he loses nothing of his singing powers.

The Woodlark, a smaller bird, sings not only in the air, but also when sitting upon a branch, in this respect differing from the Skylark.

The Wagtails and Pipits are to be found in all parts of the world, the species most common in Britain being the Pied Wagtail, who derives from his black and white plumage a very distinguished appearance. Though most of the Pied Wagtails are migrating birds, there is a resident branch which remains in these islands throughout the winter.

Yellow Wagtails

The Yellow Wagtail is a well known summer visitor. The Grey Wagtail, on the other hand, is a winter visitor, and even at that prefers the northern or colder portions of Britain.

The Spotted Flycatcher is a summer visitor, brown and white in colour. Its food consists principally of soft insects captured in flight, though, as is suggested by its nickname of "Cherry Chopper," it is rightly or wrongly suspected of a partiality to fruit. The Pied Flycatcher, chiefly black and white in colour, is occasionally but very rarely seen in England.

The Crow family is very widely distributed throughout the world. The Raven, which is the largest of the Crows, and which measures when the wings are extended about four feet across, is the hero of numberless tales both fanciful and true. This bird prefers a somewhat wild and desolate country, and is very rarely to be met with in the Midlands and southern counties of England. The Raven's nest is most generally built

in a high tree. Though he makes an attractive pet in captivity his habits in a wild state have conduced to his decreasing numbers. Should a lamb or any other animal show signs of sickness the Raven, without waiting till the end, will initiate a ferocious attack directed in the first instance in all probability at its victim's eyes. It will eat any carrion. Moles, field mice, and larger game are all seized and devoured. As a result of its depredations the Raven has gradually been driven from sheep farming districts.

SWALLOWS IN THE WAR ZONE.

The attachment of the Swallow to a particular nesting spot is undoubted. Experiment shows that the bird frequently returns in spring to the identical spot from which he set out in the autumn. This perhaps explains why Swallows, during the period 1915–1919, regularly returned to devastated France—an area most uncongenial to bird life.

The Carrion Crow is as formidable an enemy to the farmer as his greater relative the Raven. In these islands he is respon-

sible for far greater damage since the Carrion Crow exists in large numbers, although a thoroughly unpopular bird, whilst the Raven is becoming scarce.

The Hooded Crow or Grey Crow is in every respect save colour the counterpart of the less pleasantly named Carrion Crow.

The Rook, though similar in appearance to the Crow, may readily be distinguished by the fact that the lower part of his bill is destitute of feathers. He is also far less solitary in his habits. Crows hunt in pairs, whilst Rooks congregate in great numbers.

The Jackdaw, the smallest species of the Crow family, is to be found throughout Europe. His habits to a large extent are those of the Rook. He builds for preference in tall structures such as steeples and in cliffs, but he is also frequently to be found nesting in trees. His pilfering habits are, of course, well known. Very rarely is the Jackdaw's nest without some bright object which is entirely useless to the bird.

The Jay, though he exists in Britain in considerable numbers, is less known than some rarer species owing to his habit of nesting in woods, usually at the spot at which the trees are most dense. He is a handsome bird with a greyish-red plumage marked with blue and black and white on the wings, and makes an amusing pet on account of his powers of mimicry. The Magpie, another interesting pet, frequents the less populated districts.

Birds of Paradise

The Birds of Paradise, comprising a very great number of species, are natives of New Guinea and other neighbouring islands. It is at once curious and instructive that these wonderfully feathered birds, the most gorgeous in some respects of all birds, are closely related to that sombre and unprepossessing scavenger the Crow.

The Bower Birds of Australia are so called from the bowers which they construct, and which they deck with all the highly coloured objects they can secure.

The Lyre Bird of Australia is remarkable for the development of the tail feathers of the male. When fully expanded their feathers, which are extremely beautiful, combine to produce a strong resemblance to the musical instrument after which the bird is named. Whether or no this bird should be included amongst the Passerines is still a disputed point among ornithologists. The Chatterers, which include the Wax Wing, the Umbrella Bird, and so forth, also belong to the Passerines.

The Broadbills range from the Himalayas to Java; the Plant Cutters are to be found in the temperate regions of South America.

Of all migrating birds the Swallow is probably the one that figures most prominently in the imagination of Englishmen. Appearing with the spring and leaving with the autumn, it appears to typify a life of unfettered freedom. Actually, however, this welcome visitor is driven by a necessity no less severe than that which governs the actions of most breadwinners. For the Swallow takes his food upon the wing, and the cold weather, so far from being merely unpleasant, would be for him a time of virtual starvation. Viewed from this aspect, the autumn flight to Central Africa attains a new importance.

Swallows and Martins

As we have pointed out when touching on the question of migration, it is now generally accepted that the earliest Swallows to appear are those which have wintered just south of the Sahara. A little later other Swallows which spent the winter at the Cape touch at these islands upon their way to a more northern destination. The attachment of the Swallow to a particular nesting spot is undoubted, experiments with marked birds having shown that in a great number of instances the bird that returns is the identical bird that set out the previous autumn. During the period of the Great War this was noticed in the devastated parts of France—an area most uncongenial to bird life.

The House Martin resembles the Swallow in its manner of living as well as in its habits of migration. The abdominal feathers, however, are white in the Martin instead of reddish as in the case of the Swallow.

The Sand Martin, which is smaller than either of the previously mentioned members of the family, is brown above and white below. He may often be seen catching his dinner in company with the Swallow or the House Martin.

The Starling, one of the most common of British birds, is both an insect and a fruit eater. His habit when migrating and at other times of flying in dense masses is of considerable interest. On such occasions a thousand birds will wheel and mount with absolute precision. A flock of Starlings, presenting a brown colour to the eye, will instantaneously assume a lighter shade owing to the fact that each individual Starling has changed the direction of his course at precisely the same moment. A. B.

ETHNOLOGY.—IV

It is impossible to enumerate, in this summary treatment of Ethnology, the whole of man's domesticated animals and cultivated plants or to set forth their strange, and in some cases incredible, origins. What one is most struck with is the *perseverance* of man in some respects. He probably first domesticated the horse for food, but found his flesh a little too rank and indigestible. Then he made use of his strength as a draught animal; but he must have endured many a nasty tumble before he became an expert rider.

In the same way it required strong teeth, a tongue not too sensible to bitterness, to get much pleasure out of the primitive pear or crab-apple, sloe, wild grape, gooseberry, or almond, mango or pineapple. Generally, however, after long generations of smouldering experiment there is a flaring of success, the idea catches on, and then progress is comparatively at lightning speed. Nothing in all the survey of Ethnology is so amazing as the change in man's circumstances throughout the world during the past 300 years, since science was deliberately studied, was protected against the attacks of those mystics who sought short-cuts to learning by guesses and inspiration.

300 Years' Progress

The progress we have made in this period is out of all proportion to the rate at which man has advanced during a million years of humanity's existence. In these last 300 years, notably during the nineteenth century, we have really—by " we " I mean the white man sub-species and some of the more advanced types of Negro and Asiatic—advanced from the position of a specialised and aberrant anthropoid to that of a demigod, a being who has to a very great extent already brought the natural forces governing this planet under his control, who to some degree, at any rate, is becoming master of his own fate, able to ensure his own survival.

During these past 300 years—and again I must repeat, out of historical gratitude, during the nineteenth century most of all—we have worked out schemes of human government till we have arrived at what is perhaps the most perfected of all: the British constitutional monarchy. During these 300 years we have put religion in its proper place —without any detriment to true religion; for, beyond question, if true statistics and facts are worth consideration, the Christian world is very much more Christian in spirit and in action at the present day than it has ever been since Christianity was promulgated.

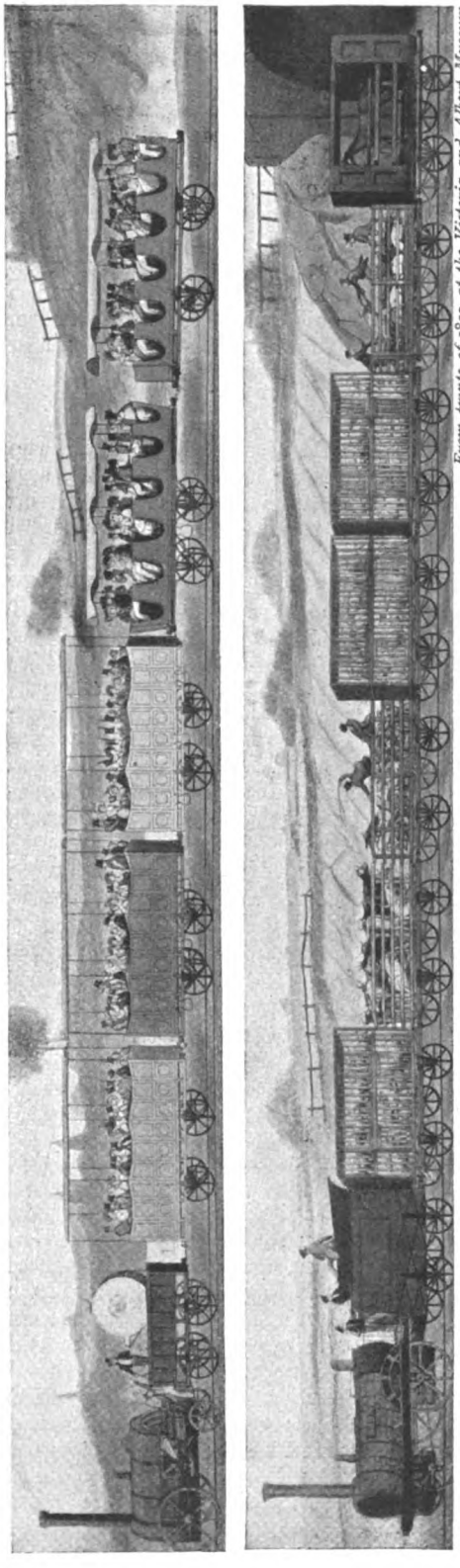
Some foreshadowing of nineteenth century humanitarianism and regard for other forms of life than man himself, appeared in the teachings of St. Francis of Assisi, a monk who spoke and thought and pleaded in the thirteenth century, who first preached brotherhood with the beast and bird, and community of life with the plant and the tree. All unconsciously he taught that Pantheism which finds God not only in the upright anthropoid, the speaking primate, but in all other manifestations of life and growth.

Medical Science

During the nineteenth century in the civilised countries of Europe, America, and Asia hospitals have been organised on scientific lines for the restoration to health of the sick and wounded, and anæsthetics have been invented or developed which have diminished by three-quarters the acute suffering and danger to life of surgical operations and of that terrible travail in child-birth which is the lot of most women. The origin of germ-diseases has been explored and at last realised, and practical measures commenced for the extermination of these germs which are the cause of three-quarters of the maladies afflicting man, beast and plant.

The adulteration of food has been of late taken seriously. The horrible poison of alcohol is beginning to be repressed, despite the furious resistance of those who have invested their money in this baleful product of human ingenuity—a product, however, of immense, unestimated importance in chemistry, one of those poisons which, like strychnine, arsenic, strophanthine, may be only a drug in disguise, a Jin which can be a trusty servant under proper control. Sanitation has been at last understood and applied.

This lack of sanitation, this neglect to destroy the poison in fæcal matter and in decayed substances, had been the cause of more than half the human diseases. When there were only ten or fifteen millions of men spread about the open spaces of the Old World, they had no need to trouble themselves much concerning sanitation. Ancient man was a nomad; and when the human herd had exhausted the food supply of the neighbourhood, it moved on, leaving behind it its exuviæ and rubbish heaps to become harmless manure. But when mankind had acquired more settled habits and the com-



From prints of 1833 at the Victoria and Albert Museum.

THE RAILWAY ENGINE OF YESTERDAY
and types of rolling stock used on the Liverpool and Manchester Railway in 1833.

munities grew from thirty to forty individuals into tribes of hundreds and thousands, when the congeries of huts and earth shelters grew into towns ringed in by thorn hedges, banks and dykes and walls, then the need for sanitary science arose ; for the refuse of the community, the sewage, bred the germs of one devastating disease after another.

There were allies in Nature : there was the sun that blazed down and killed the germs at some seasons ; the floods of rain that washed them away at another. There were the friendly bacilli, the ferments, the animalcules, the insects, the beast and bird scavengers that did some good work in the absorption of filth and corruption. But these terrible diseases occasionally got the upper hand, especially when increasing civilisation drove away the beasts and the birds and hid the unpleasantnesses of life (to Man's great danger).

There were devastating plagues, appalling epidemics of smallpox, of influenza, scarlet-fever and cholera. Tuberculosis in many different forms claimed an increasing roll of victims. The dreadest and awfullest of all diseases, cancer, became evident. Appendicitis peeped out for the first time, so far as our records go, in the nineteenth century, in which period typhoid, spotted fever, the hook-worm disease, hæmoglobinuria, Bright's disease, were first analysed, coped with, and to some extent made curable.

Prison Reform

And not only has the nineteenth century seen war at last waged on scientific lines against the diseases of the body, but we have begun to grapple with the diseases of the mind.

This century began prison reform on a great scale. The prisons of the world—above all, of the civilised world—down to about the middle of the nineteenth century were one of the scandals of humanity—breeding-grounds of worse crime and of the most horrible diseases. We have realised at last that the just punishment of imprisonment must be made as far as possible curative, not merely punitory and deterrent. The treatment of mad people has been similarly developed out of procedure which was merely stupid cruelty into a curative science.

The nineteenth century has seen the origin and growth of such marvels of human invention that it is impossible to do justice to them in a few pages of print. There has been photography, the invention of chemical processes by which light may be made to

record pictures of actuality, pictures which can now be recorded faithfully in colour as well as in light and shade.

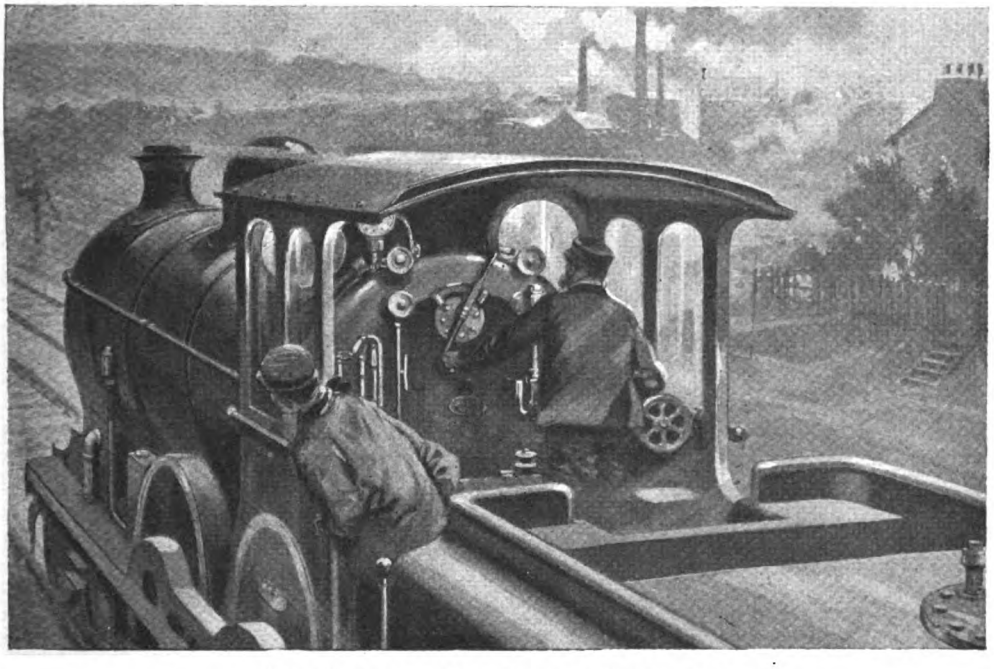
There has been at the same time an enormous improvement in the arts—in the art of sculpture, a truer and truer appreciation of the beauty of the human figure and of the contours and modelling of beasts. It is true that in this direction we have advanced but little farther than the seventh wave, which marked the highest tide of Egyptian and of Greek mastery over clay and stone at different periods between 6,000 and 2,300 years ago. But it is something to have regained the same position in the pursuit and achievement of beauty.

The painting schools of the world during the last hundred years have, in their power to appreciate and render Nature, advanced in line and colour far beyond the draughtsmen and painters of previous centuries. Our architecture is superior to that of any preceding age, if not in beauty of conception yet in cunning of structure, in adaptation to innumerable requirements, in appreciation of strict sanitation, of daylight-value, of economy of ground space, of colour and of comfort, and of appropriateness to surroundings.

In natural science, think on what we have achieved even during the lifetime of the middle-aged among us at the present day! We have seen the Darwinian theory propounded which, imperfect though it be in its detailed explanations, was, like the wilder guesses of La Place at the beginning of the nineteenth century, the first rational explanation of the mysteries of creation.

Astronomical science has opened up the universe to our contemplation with a degree of rapidity in discovery and vastness of plan that leaves us dazed and somewhat frightened at our own immeasurable littleness. Yet microscopy and the science of the infinitely little have enlarged our conceptions in the opposite direction, and to some extent are a counter weight against the despair engendered by telescopy.

Music, beginning with Beethoven and passing through the achievements of Mende's



THE RAILWAY ENGINE OF TO-MORROW.

In view of the high price and scarcity of coal, oil is likely soon to be largely used as locomotive fuel. So long ago as 1913 the G.E.R. was experimentally adapting engines. A French railway, the P.L.M., has shown itself to be the first definitely to adopt the new system. The plant modifications, which are simple and inexpensive, consist in the substitution of reservoirs for coal bunkers, in constructing conducting tubes to the burners, and in surrounding steam tubes with refractory bricks. The oil engine gives very little smoke, reduces the weight of fuel to be carried by one half, and saves much labour: there are no cinders to be dealt with.

sohn, Schumann, Gounod, Wagner, Sullivan, and St. Saëns to the compositions of Parry, Mascagni and Strauss : music, that witchery over the air vibrations which Du Maurier thought might be a path for easier communion with God : has had with the other arts an equally amazing development and evolution during the last hundred years.

Shipbuilding has made advances equally unforeseen and incredible during this same period.

A hundred years ago an experimental steamer had been made for river traffic, more as an amusing toy than anything else ; just as steam engines were being applied in a tentative and frightened fashion to certain industries. A little later on it occurred to one or more bold spirits that a wooden vessel plated outside with iron was much stronger and did not necessarily sink ; and, by a sudden leap of thought that you could do without the wood and send an iron hull to sea if it had enough air space in it to be buoyant.

The conjunction of the two ideas—the iron vessel (and now it is often steel and aluminium, and not iron) and steam power, gave us something approaching much nearer to a mastery over the ocean than the canoes, the plank boats, the wooden castles of our ancestors, propelled by paddle, oar, or the wind power in the sail.

Railways and Posts

It is conceivable that when war between man and man is at an end and we fight only against the elements, that ships may be made so large, so certain of movement, so irresistible, that tempests, tall waves, and even collisions with icebergs, will affect their safety or their progress to no appreciable degree. Some new motive power may be adapted or invented which will urge floating islands, monstrous ferry boats across the ocean at the same rate as express trains are propelled along iron rails on shore.

The railway is one of the outstanding inventions to the credit of the nineteenth century, it has gone far towards annihilating earthly space. A man or woman can cross America at its broadest from the Atlantic to the Pacific in seven days (or less) ; a journey of 3,000 miles ; such as their immediate ancestors who colonised the Far West occupied two years in making with wagon or with birch-bark canoe.

Weaving is no longer done by hand on wooden looms ; it is a matter of nicely adjusted, infinitely complicated machinery, with an output a hundred fold, a thousand fold more than the produce of Manchester in 1800 or 1830. Fruit and fish, milk and cheese, meat and vegetables, can be preserved in one part of the world and sent 8,000 miles, to another part in perfect condition and of some duration in that state. The people of Ireland can eat of the produce of New Zealand, the planter in Java can rejoice in Danish butter, the poor men, women and children in the icy streets of a Canadian town can buy for two cents—a penny—the banana which is grown in Equatorial America ; just as their poverty-stricken comrades in England or France can obtain the bananas of the Canary Islands or the apples of the Cape of Good Hope.

Think of the extent to which our postal service has been developed in a hundred years ! The celerity of it, the security of it ! Before the War, you could send a postal order from Yakutsk, the most Arctic of Russian towns in the very north-east of Siberia, to Capetown, or to California ; you can send a parcel from New Guinea to Tipperary, a post card from the heart of Africa to the frontier of Tibet. Telegraph cables are laid along the beds of deep oceans for thousands of miles.

Wonders of Electricity

A hundred years ago the only idea—the nascent idea—of the telegraph was to set up on hills or steeples an apparatus like a windmill or a railway signal. The position and movements of these slabs of wood at intervals of a mile or so would enable a message to travel across France from the English Channel to the Pyrenees or the Mediterranean at the rate of about a mile a minute, so that if for State purposes you required to send a telegram 500 miles across France, it would take at least 500 minutes, or approximately eight hours, in its despatch. Now you could send a telegram from Calais to Marseilles in a few seconds and probably converse along a telephone wire between Marseilles and Paris : just as, far south in the United States, you can hear people talking in Canada. Still more amazing has been the application of the Marconi discoveries—*wireless* telegraphy.

Other mysterious forces of the atmosphere and of ether outside the atmosphere have been enchained for the service of man during this same wonderful hundred years. There are the X-Rays and the N-Rays, and other compositions of light which are made to reveal secrets of structure or to check diseases.

Think again of our geographical dis-

coveries during the same period; how we have laid bare the North Pole and the South Pole, the whole of Africa's geography —virtually a blank on the atlases of 1800; similarly, the revelation of the secrets of Tibet, of New Guinea, of Indo-China, Arabia, Australia, and central South America.

A hundred years ago Mount Everest was neither known, named, nor measured in its altitudes; the heights of the Andes were imperfectly appreciated; nothing was really known of the great snow mountains of Equatorial Africa or Equatorial New Guinea, of New Zealand, of Alaska, and even of the Caucasus and Southern Siberia. The courses of the Nile, the Amazon, the Congo, the Niger, the Zambesi, the Yangtse Kiang, and the Orinoco, had not been traced from source to sea. The Fiji Islands and several other Pacific archipelagoes, the North-west Passage, or the great water route across North America, the caravan routes across the Sahara and the Central African lakes, had not been discovered. Nothing was known, outside its own limits, of the hidden civilisation of Uganda or of Bushongo.

One Hundred Years Ago!

Most of the more remarkable wonders of Egypt; of Egyptian, Central and South African archæology, were unrevealed. Nothing was known of the buried civilisation of Turkestan and of the Chinese deserts, of Troy and Crete, of Cyprus and of Hallstadt. Nothing was known about Cave Man, his drawings, paintings, engravings and sculpture. Very little was known about Palæontology or the science of extinct animals, and still less about Palæobotany or the science of bygone vegetable growths. Petroleum was not realised as an important factor in industry, in locomotion, and in lighting.

Again—but little had been done to study the science of human languages, to appreciate their diversity of forms and their interrelationships. A few great Orientalists had begun to propound the Aryan idea, the relationship in language between peoples of Northern India and of Europe. The scope and spread of the Semitic languages was very dimly appreciated; that of the Hamitic tongues scarcely understood. The Bantu languages of Africa—their widespread area and importance—were still behind the veil.

Egyptian hieroglyphs were undeciphered, and all the amazing lore of ancient Egypt was a book as yet unopened. Little or nothing was known about Japan, its art and its lovely civilisation, as we know it today, and equally little about ancient China. Anthropology and ethnology as sciences had scarcely come into existence by the beginning of the nineteenth century.

Engineering was in its infancy. It had achieved a few canals, but the idea of the modern suspension bridge would have been looked upon as positively irreligious a hundred years ago. Tunnelling was as primitive as its name, which is derived from that of a huge cask of wooden staves which gave man the first idea of shoring up a passage dug in the bowels of the earth.

The newspaper press was puny and wielded but little influence. Newspaper readers were to be numbered a hundred years ago by the hundred thousand rather than the hundred million.

The stage was tawdry, held up no true mirror to life, was a mixture of ranting oratory, stupid buffoonery, scarcely veiled obscenity, physical dirt as well as mental, bad smells, miserable lighting from stinking candles (for a hundred years ago there was no gas in any theatre), childishly painted scenery, gaudy costumes.

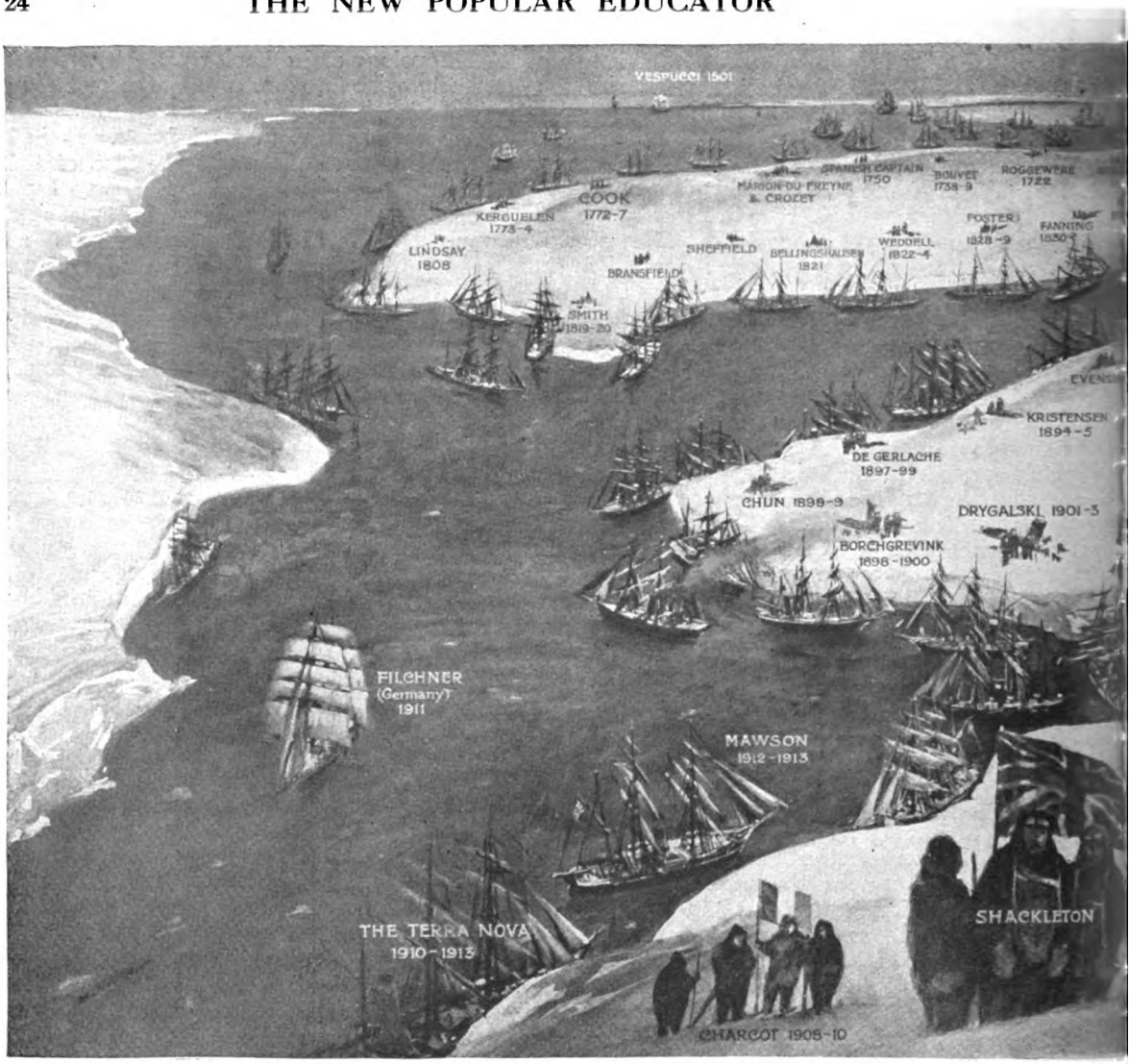
A hundred years ago, though Scott was beginning his Waverley series, very few novels had been written which gave a truthful picture, either of life in the times of the author or of life in earlier centuries. There were no illustrated papers; wood engraving was in its infancy; there were no zoological gardens, no aquariums, no decent places of amusement.

Woman without Rights

The country roads were only beginning to be macadamised and the streets of towns were nerve-racking with their rough cobble stones as paving. Such aids to quiet and smooth progress in great cities as wood pavements, asphalt pavements, were unheard of till the late middle of the nineteenth century. The streets of all towns were as filthy as they were narrow and noisy.

Street lighting scarcely existed a hundred years ago. The shop fronts were small paned, dark and mean. Any such institutions as the big departmental stores would, like so many other necessities at the present day, have been regarded as irreligious, a flying in the face of Providence.

It was equally regarded as an interference with divine ordinances to prevent cruelty to children, either on the part of parents and schoolmasters or of the employers of cheap labour. Woman had absolutely no rights; she was a chattel, a creature that man could do with as he pleased. If she married, all her property mechanically went



A PICTORIAL RECORD OF ANTARCTIC ENDEAVOUR.

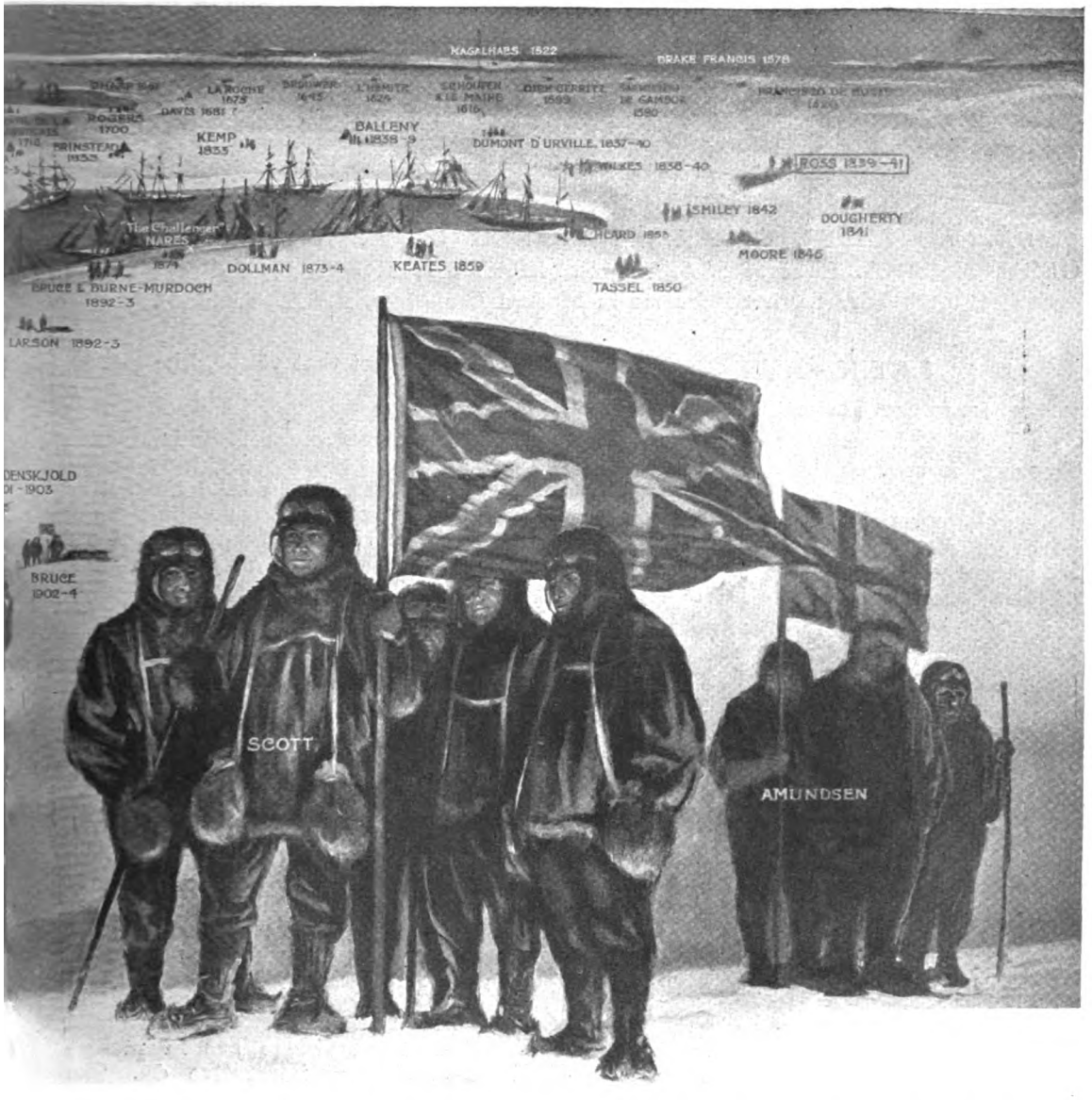
The story begins with the expedition of Amerigo Vespucci, who set out in 1501 to explore the coast of Brazil, but who was driven from his course and apparently discovered South Georgia. The story culminates in the glorious achievement of Captain Robert Falcon Scott, who reached the South Pole in December, 1911.

to her husband. She could not divorce him, she could not even own her children.

A hundred years ago hypocrisy on a large scale was organised by the State. Whatever your private religious convictions might be, you could not serve that State unless you swore you were a member of the Established Church of England. You were penalised if you were a Roman Catholic, a Jew, or a member of the Free Churches.

It is the business of ethnology to take note of these changes, to take note of everything that plays a part on a larger or a smaller scale in the amazing evolution of man. And, so that we may realise for our own encouragement and that of our descendants what we have passed through to reach our present pinnacle of greatness, Ethnology must burrow into the past. Anthropologists and ethnologists must learn to read those chapters of the New Bible which deal with the evolution of man's body and man's mind. Very imperfect chapters they are: so much has been lost, so much as yet remains unrevealed.

There is here a bone, and there an implement; in another place is dug up a skull or brain-case, still retaining the impressions on its inner surface of the brain that decayed



therein hundreds of thousands of years ago. Ten, twenty feet below the surface lies a complete skeleton, and perhaps the petrified soil in which the body had been embedded gives us an exact mould of the conformations of the corpse. There are petrified foot-prints; and over and above these scanty records of the past there are living to-day amongst us savage peoples, wild sub-species of man who are still reproducing the physical type of life of our remote ancestors.

Ethnologists are better off than anthropologists. Their chapters are far fuller in records, they have the artefacts of early man, his drawings and his paintings; the implements, the adornments that were buried with him, the now sanctified and purified remnants of his rubbish heaps, the shell mounds of his ancient feasts. They have the histories written on stone and on papyrus fibre, on parchment and vellum, on brass and wood; the books of the ancients, the books of the Middle Ages and of the Renaissance, the pictures, the sculpture, the temples of bygone centuries. They have also the records and the countless activities of to-day.

Anthropologists and ethnologists alike must also live in the present and may perhaps permissibly forecast the future, prepare the way for it, even mould the aspect it shall take. H. H. J.

Continued from Vol. II., page 482.

LANGUAGES:

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LATIN.—XVII

Irregular Verbs (*Continued*)

VII. **fīō**, *I become* or *am made.*

THIS verb is used as the passive of **făcĭō**, *I make*, in tenses from the present base. Its simple tenses are active in form though passive in meaning. The compound tenses are formed with **factus**, the past participle of **făcĭō**, and the gerundive is **făcĭendŭs.**

Chief Parts:—**fīō, factŭs sum, fĭĕrī**

Indicative Mood

PRESENT	IMPERFECT	FUTURE
fīō	fīēbam	fiam
fīs	fīēbās	fiēs
fīt	fīēbăt	fiĕt
(fīmŭs)	fīēbāmŭs	fiēmŭs
(fītĭs)	fīēbātĭs	fiētĭs
fīunt	fīēbant	fient

PERFECT	PLUPERFECT	FUTURE PERFECT
factŭs sum, etc.	factŭs ĕram, etc.	factŭs ĕrō

Subjunctive Mood

PRESENT	IMPERFECT
fiam	fĭĕrem
fiās	fĭĕrēs
fiāt	fĭĕrĕt
fiāmŭs	fĭĕrēmŭs
fiātĭs	fĭĕrētĭs
fiant	fĭĕrent

PERFECT	PLUPERFECT
factŭs sim, etc.	factŭs essem, etc.

Imperative Mood

PRESENT fī, fītĕ FUTURE *none*

Infinitive Mood

PRESENT	PERFECT	FUTURE
fĭĕrī	factŭs essĕ	factum īrī

Participles

PERFECT	GERUNDIVE
fact-ŭs, -ă, -um	făcĭend-ŭs, -ă, -um

There are a few other quasi-passive verbs like **fĭĕrī**, as **exŭlō**, *I am banished*, **văpŭlō**, *I am beaten*, **lĭcĕō**, *I am for sale*, **vēnĕō**, *I am sold.* The fact that **vēnĕō**, like **pĕrĕō**, *I perish*, is a compound of **ĕō**, gives one a clue to the real meaning of this class of verbs. Though we render them in English by verbs in the passive voice, they are in reality neuter verbs, and take the active form quite naturally. Thus **văpŭlō** may be translated *I receive a beating*, **exŭlō**, *I am in exile*, and **vēnĕō**, *I am for sale.*

VIII. **dō**, *I give.*

Chief Parts:—**dō, dĕdī, dătum, dărĕ**

Indicative Mood

PRESENT	IMPERFECT	FUTURE
dō	dăbam, etc.	dăbō, etc.
dās		
dăt		
dămŭs		
dătĭs		
dant		

Subjunctive Mood

PRESENT dem, etc. IMPERFECT dărem, etc.

Imperative Mood

dā, dătō, dătĕ, dātōtē, etc.

Except as shown above, **dō** regularly follows the first conjugation, having **ă** instead of **ā** everywhere but in present indicative **dās** and imperative **dā.** The old present subjunctive forms **dŭĭm, dŭĭs, dŭĭt, dŭĭnt**, sometimes occur instead of **dem, dēs, dĕt, dent.**

Compounds with prepositions of two syllables are conjugated like **dō**; those with prepositions of one syllable follow the third conjugation, thus:—

Circumdō, circumdĕdī, circumdătum, circumdărĕ, *surround.*

Condō, condĭdī, condĭtum, condĕrĕ, *put together, build.*

Ēdō, ēdĭdī, ēdĭtum, ēdĕrĕ, *put forth, publish.*

Defective Verbs

Defective verbs are those which are lacking in certain tenses or persons. First we will take three verbs, **āiō**, *I say*, or *affirm*

inquam, *I say*, and **fārī**, *to speak*, allied in meaning, and used in only a few tenses:—

āiō, *I say.*

Indicative Present.—āiō, āis, āĭt, and āiunt.
Subjunctive Present.—āiās, āiāt, and āiant.
Indicative Imperfect.—āiēbam, -bās, -bāt, -bāmŭs, -bātĭs, -bant.
Indicative Perfect.—āīt.
Present Participle.—āiens, -entĭs.

inquam, *I say.*

Indicative Present.—inquam, inquĭs, inquĭt, inquĭmŭs, inquĭtĭs, inquĭunt.
Indicative Imperfect.—inquĭēbăt (*or* inquībăt).
Indicative Future.—inquiēs, inquiĕt.
Indicative Perfect.—inquistī, inquĭt.
Imperative.—inquĕ, inquĭtō.

fārī, *to speak.*

Indicative Present.—fātŭr.
Indicative Future.—fābŏr, fābĭtŭr.
Indicative Perfect.—fātŭs est.
Indicative Pluperfect.—fātŭĕram, fātŭĕrăt.
Imperative Present.—fārĕ.
Infinitive.—fārī.
Present Participle.—fantem (acc.), fantī (dat.).
Perfect Participle.—fātŭs, fātă.
Gerundive.—fandŭs, fandă, fandum.
Gerund.—fandī, fandō.
Supine.—fātū.

Next comes a group of four verbs, **mĕmĭnī**, *remember*, **ōdī**, *hate*, **coepī**, *began*, and **nōvī**, *know*, used only in the perfect tenses. Three of these, however, **mĕmĭnī**, **ōdī** and **nōvī**, have a present signification, a circumstance easily understood if the meaning of the perfect tense is analysed. Thus **nōvī** is the perfect of the inceptive verb **noscō**, *I become acquainted with*, the result of which process is *to know*. The other three in this group have no present base. Those four perfects are regularly conjugated. Observe that when the meaning of the perfect form is conveyed by the English present, the meaning of the pluperfect will be conveyed by the imperfect, and so on.

INDICATIVE PERFECT	SUBJUNCTIVE PERFECT
mĕmĭnī, *I remember.*	mĕmĭnĕrim, *I may remember.*
ōdī, *I hate.*	ōdĕrim, *I may hate.*
coepī, *I begin.*	coepĕrim, *I may begin.*
nōvī, *I know.*	nōvĕrim, *I may know.*
INDICATIVE PLUPERFECT	**SUBJUNCTIVE PLUPERFECT**
mĕmĭnĕram, *I remembered.*	mĕmĭnissem, *I might remember.*
ōdĕram, *I hated.*	ōdissem, *I might hate.*
coepĕram, *I began.*	coepissem, *I might begin.*
nōveram, *I knew.*	nōvissem, *I might know.*

FUTURE PERFECT	IMPERFECT
mĕmĭnĕrō, *I shall remember.*	mĕmentō, *remember thou.*
ōdĕrō, *I shall hate.*	mĕmentōtĕ, *remember ye.*
coepĕrō, *I shall begin.*	
nōvĕrō, *I shall know.*	

INFINITIVE PERFECT	PERFECT PAST PARTICIPLE
mĕmĭnissĕ, *to remember.*	ōsūrŭs, *about to hate.*
ōdissĕ, *to hate.*	ōsŭs, *hated.*
coepissĕ, *to begin.*	coeptūrŭs, *about to begin.*
nōvissĕ *or* nosse, *to know.*	coeptŭs -ă -um, *begun.*
	nōtŭs (adj.), *known.*

The perfect participle passive of **coepī**, viz. **coeptŭs, -ă, -um**, is used with **sum**, etc., to form the perfect tenses in the passive ; and with a passive verb is often used instead of the active form, thus **ăgrī dēpŏpŭlārī coeptī sunt**, *the lands began to be ravaged*, that is, *they began to ravage the fields*, or **urbs aedĭfĭcārī coeptă est**, *the city began to be built*, that is, *they began to build the city.* A similar construction occurs with **dēsĭnō**, *cease*, as in **urbs aedĭfĭcārī dēsĭtă est**, *they have discontinued the building of the city.*

There are other verbs of which only two or three forms exist.

Avē (or **hăvē**), *hail!* has only the imperatives **ăvē**, **ăvētō**, **ăvētĕ**, and the infinitive **ăvērĕ**. **Cĕdō**, and its plural **cĕdite**, *give, tell*, are the surviving imperatives of an obsolete verb. **Quaeso**, *I pray*, and the plural **quaesŭmŭs**, *we pray*, are the only forms used absolutely or as a mere interjection, *pray!* **Salvē**, *hail! save you!* has only the imperatives **salvē**, **salvētĕ**, **salvētō**, the injunctive **salvērĕ**, and the future **salvēbĭs**.

Impersonal Verbs

Impersonal verbs are those which express an action or state without a personal subject, and which always appear in the third person singular. Though they undergo no inflection of number or person, they are regularly conjugated with regard to tense and mood. The majority of such verbs have no reference in meaning any more than in grammar to any definite subject, being rendered in English by a verb with the nominative *it*, thus **plŭĭt**, *it rains*, **ningĭt**, *it snows.* Others, such as **dĕcĕt**, *it becomes*, or **ŏportĕt**, *it behoves*, may have as their subject a neuter pronoun, an infinitive, or a whole sentence. These last are of course transitive verbs.

(*a*) Impersonal verbs denoting the state of the weather :—

PRESENT	PERFECT	INFINITIVE	
grandĭnāt		grandĭnārĕ	*it hails.*
lucescĭt *or* luciscĭt		lūcescĕrĕ	*day breaks.*
illūcescĭt *or* illūciscĭt	illuxĭt	illūcescĕrĕ	*day breaks.*
ningĭt *or* ningŭĭt	ninxĭt	ningĕrĕ	*it snows.*
plŭĭt	plŭĭt *or* plūvĭt	plŭĕrĕ	*it rains.*
tŏnāt	tŏnŭĭt	tŏnārĕ	*it thunders.*
vespĕrascĭt	vespĕrāvĭt	vespĕrāscĕrĕ	*evening comes on.*

Note that **tŏnăt**, third person of **tŏnō**, *I thunder*, is placed here merely as an example of a verb used impersonally. Many other verbs are so used in special significations, e.g. **accĭdit**, *it happens*, **convĕnit**, *it is agreed*, **rĕpert**, *it concerns*, or **stăt**, *it is acknowledged.*

(*b*) A large number of impersonal verbs express states of mind—obligation, necessity, and similar ideas. The majority of these belong to the second conjugation. Here are those most commonly in use :—

PRESENT	PERFECT	INFINITIVE	
mĭsĕrĕt	mĭsĕrŭĭt	mĭsĕrērĕ	*it moves to pity.*
pĭgĕt	pĭgŭĭt	pĭgērĕ	*it vexes.*
paenĭtĕt	paenitŭĭt	paenĭtērĕ	*it repents.*
pŭdĕt	pŭdŭĭt *or* pŭdĭtum est	pŭdērĕ	*it shames.*
taedĕt	taedŭĭt *or* pertaesum est	taedērĕ	*it wearies.*
dĕcĕt	dĕcŭĭt	dĕcērĕ	*it is becoming to, it beseems.*
dēdĕcĕt	dēdĕcŭĭt	dēdĕcērĕ	*it is unbecoming, it misbeseems.*
lĭbĕt	lĭbŭĭt *or* lĭbĭtum est	lĭbērĕ	*it is pleasing.*
lĭcĕt	licŭĭt *or* lĭcĭtum est	lĭcērĕ	*it is lawful.*
ŏportĕt	oportŭĭt	ŏportērĕ	*it behoves.*
lĭquĕt		lĭquērĕ	*it is clear.*

Lĭbĕt and **lĭcĕt** are commonly used with the dative, as **lĭbĕt tĭbī**, *it is pleasing to thee*, or *thou art disposed* or *you like ;* **nōn lĭcĕt tĭbī**, *it is not lawful to thee* or *thou art not permitted.* These two verbs may also be used with an infinitive or sentence, or with a neuter pronoun, as subject. The other verbs given above are usually constructed with the accusative, thus **mē mĭsĕrĕt**, *it moves one to pity*, or *I pity ;* **nōs paenĭtĕt**, *it repents* or *we are sorry ;* **pŭdĕt vōs**, *it shames you* or *you are ashamed.* The impersonal verbs **mĭsĕrĕt**, **pĭgĕt**, **paenĭtĕt**, **taedĕt**, and **pudĕt** are frequently followed by an accusative of the person affected, and a genitive of the thing producing the effect. The following examples illustrate this usage :—

nĕquĕ tē mĕī tergī mĭsĕrĕt	*you feel no pity for my back* (lit., it does not distress you concerning my back).
fratrĭs mē pĭgĕt.	*I am vexed with my brother* (lit., it vexes me concerning my brother).
tē tŭae laudĭs nōn paenĭtĕt.	*you are not sorry for your own praise* (lit., it does not repent you on account of your praise).
multōs hŏmĭnēs vītae taedĕt.	*many men are weary of their life* (lit., it disgusts many men concerning life).
mē pŭdĕt tantī mălī.	*I am ashamed at such an evil as that* (lit., it shames me concerning such an evil).

The third person singular of intransitive verbs is frequently used in the passive in an impersonal sense, thus :—

sīc ītŭr ăd astra,	*thus people reach the stars.*
bĭbĭtŭr *or* bĭbĭtum est,	*drinking is going on.*
ventum est,	*they* (or *we*, etc.) *have come.*

Note that the neuter participle is always used when the verb is in the perfect, pluperfect, or future perfect tense.

Exercise 16

1. Quo simul ventum est. 2. Veteres orationes a plerisque legi sunt desitae. 3. Ex omnibus locis in forum curritur. 4. Persei nunquam desitum celebrari nomen. 5. Ex quovis ligno non fit Mercurius. 6. Ex nihilo nihil fit.

1. To make a mistake twice is not permitted in war. 2. At times (even) a fool speaks wisely (well). 3. A liar ought to have a good memory. 4. It befits a youth to be modest. 5. No wrong is done to a consenting party. 6. It hurts me when I am beaten. 7. When they arrived there (when there was arrival there).

Key to Exercise 15

1. It is not every man's lot to go to Corinth. 2. Nor should a god (be called upon to) intervene unless the knot be worthy of such a vindicator. 3. Considering nothing achieved while anything remained to be achieved. 4. The gift of what is required is twice as welcome if you offer it willingly. 5. If anyone spares the bad he injures the good. 6. This man since he lacks honest abilities tries to get on by means of craft and trickery.

1. Alii aliam in partem perterriti ferebantur. 2. Suis auxilium ferre non poterant. 3. Graecorum quoque urbes adire volebat. 4. Supplex deorum aras adibat. 5. Miserrimus est, qui quum esse cupit, quod edit (edat) non habet. 6. Meander in sinum maris editur.

E. A. B.

FRENCH.—XVII

Neuter or Intransitive Verbs form their compound tenses with the auxiliary **avoir** or **être**. The general distinction between these two auxiliaries is that **avoir** is used when the main verb expresses action, and **être** when it expresses situation or condition: thus—

Votre frère a-t-il parti ce matin ?	*Has your brother gone away this morning ?*
Votre frère est-il sorti ?	*Is your brother out ?*

Almost all intransitive verbs take the auxiliary **avoir**, as in—

Nous avons couru, marché, parlé,	*We have run, walked, talked.*
Les demoiselles ont chanté,	*The young ladies sang*

The compound tenses of a few neuter verbs, however, are formed with **être**, comprising the following :—

aller, *to go.*
arriver, *to arrive.*
choir, *to fall ;* échoir, *to fall due.*
décéder, *to die.*
éclore, *to be hatched.*
entrer, *to enter.*
mourir, *to die.*
naitre, *to be born.*
partir, *to go away.*
sortir, *to go out.*
tomber, *to fall ;* retomber, *to fall again.*
venir, *to come ;* devenir, *to become ;* intervenir, *to interfere ;* parvenir, *to succeed ;* revenir, *to return ;* survenir, *to happen unexpectedly.*

Other verbs, which may express either an action or a situation, such as **accourir**, *to run up to*, **apparaître**, *to appear*, **demeurer**, *to reside*, **descendre**, *to descend*, **disparaître**, *to disappear*, **passer**, *to pass*, **rester**, *to remain*, take sometimes **être** and sometimes **avoir**, strictly according to the sense. On the other hand, verbs of a similar nature, as **courir**, *to run*, **marcher**, *to walk*, **succomber**, *to give way*, **voyager**, *to travel*, always take **avoir.**

Examples :—

Troie a disparu de la surface de la terre.	*Troy has disappeared from the face of the earth.*
Le vaisseau est maintenant disparu.	*The ship is now out of sight.*
Nous avons marché huit lieues.	*We have walked eight leagues.*
Il est parti.	*He is gone.*

Remember that the participle must agree in gender and number with the subject if the auxiliary used is **être**, as in the following :—

Le médecin est allé à Londres,	*The doctor is gone to London*
Votre sœur est allée à l'église,	*Your sister is gone to church.*
A quelle heure êtes-vous venu (or venue) ?	*When did you come ?*
Ma fille est arrivée ce matin.	*My daughter arrived this morning.*
Nos frères ne sont pas venus,	*Our brothers are not come.*

The past indefinite or perfect of **être** is used, as above, instead of that of **aller** (**je suis allé**, etc.) in speaking of *having been* at a place, with the distinction that **être** implies return but **aller** does not. The idiom is on all fours with the English *he has been* and *he went.*

Examples :—

Le médecin a été à Paris,	*The doctor has been at Paris.*
J'ai été à l'église ce matin,	*I went to church this morning.*
Elle est allée en Angleterre.	*She is gone to England.*

The past participle with **avoir** agrees with the direct object when that *precedes* the auxiliary but not when it *follows*, thus :—

Les dames que nous avons vues,	*The ladies that we have seen.*
Les lettres que nous avons lues,	*The letters that we have read.*
Avez-vous vu les dames ?	*Have you seen the ladies ?*
Avons-nous lu les lettres ?	*Have we read the letters ?*

Used attributively, the past participle follows the rule for adjectives, as in—

Des livres bien imprimés,	*Well-printed books.*

When the past participle belongs to the relative pronoun **en**, it remains invariable, thus :—

Avez-vous apporté des plumes ?	*Have you brought pens ?*
J'en ai apporté,	*I have brought some.*

Reflexive or Pronominal Verbs.—A verb is called pronominal when it is conjugated with two pronouns of the same person, the one representing the subject, and the other the direct or indirect object. Such verbs are reflexive, that is, they express an action performed by and suffered by the subject, as in **il se flatte**, *he flatters himself.*

There are two classes of such verbs, (1) those that are reflexive by nature, as **s'évanouir**, *to vanish*, **s'envoler**, *to fly away*, **se souvenir**, *to remember* ; and (2) active or neuter verbs used reflexively, as **se laver**, *to wash* (oneself), **se nuire**, *to hurt oneself.*

What is sometimes differentiated as a third class, verbs expressing reciprocal action between two or more subjects, as **nous nous aiderons l'un l'autre**, *we shall help one another ;* **ces enfants s'entr'aiment,** *those children love one another*, are merely special examples of the second class.

Reflexive verbs are conjugated with **être**

in their compound tenses. In the compound tenses the participle agrees with the subject if the verb is reflexive by nature, as in **ils se sont eveillés**, *They have woke up*, or an active verb used reflexively and preceded by its direct object, as in **ils se sont flattés**, *They flattered one another*. If the verb is neuter, or if it is active and *followed* by its direct object, the participle remains unchanged ; thus—

Ils se sont nui l'un à l'autre,	*They have injured each other,*
Ils se sont fait du mal,	*They have done each other harm.*

Reflexive Verb.—Se flatter, *to flatter oneself.*

Se flatter, se flattant, flatté, je me flatte, je me flattai.

Indicative Mood

PRESENT	PAST INDEFINITE
je me flatte, *I flatter myself,*	je me suis flatté or flattée, *I have flattered myself.*
tu te flattes.	tu t'es flatté or flattée, *I have flattered myself.*
il se flatte	il *or* elle s'est flatté or flattée, *I have flattered myself.*
nous nous flattons	nous nous sommes flattés or flattées.
vous vous flattez	vous vous êtes flattés or flattées.
ils se flattent	ils se sont flattés, elles se sont flattées

IMPERFECT	PLUPERFECT
je me flattais, *I flattered myself* or *was flattering myself.*	je m'étais flatté or flattée, *I had flattered myself.*
tu te flattais	tu t'étais flatté or flattée, *I had flattered myself.*
il se flattait	il *or* elle s'etait flatté or flattée, *I had flattered myself.*
nous nous flattions	nous nous étions flattés or flattées.
vous vous flattiez	vous vous étiez flattés or flattées.
ils or elles se flattaient	ils s'étaient flattés. elles s'étaient flattées.

PAST DEFINITE	PAST ANTERIOR
je me flattai, *I flattered myself*	je me fus flatté or flattée, *I had flattered myself.*
tu te flattas	tu te fus flatté or flattée, *I had flattered myself.*
il se flatta	il *or* elle se fut flatté or flattée, *I had flattered myself.*
nous nous flattâmes	nous nous fûmes flattés or flattées
vous vous flattâtes	vous vous fûtes flattés or flattées
ils se flattèrent	ils se furent flattés elles se furent flattées

FUTURE	FUTURE ANTERIOR
je me flatterai, *I shall flatter myself*	je me serai flatté or flattée, *I shall flatter myself*
tu te flatteras	tu te seras flatté or flattée, *I shall flatter myself*
il se flattera	il *or* elle sera flatté or flattée, *I shall flatter myself*
nous nous flatterons	nous nous serons flattés or flattées.
vous vous flatterez	vous vous serez flattés or flattées.
ils se flatteront	ils se seront flattés elles se seront flattées.

Conditional Mood

PRESENT	PAST
je me flatterais, *I should flatter myself*	je me serais flatté or flattée, *I should have flattered myself.*
tu te flatterais	tu te serais flatté or flattée, *I should have flattered myself.*
il se flatterait	il *or* elle se serait flatté or flattée, *I should have flattered myself.*
nous nous flatterions	nous nous serions flattés or flattées.
vous vous flatteriez	vous vous seriez flattés or flattées.
ils se flatteraient	ils se seraient flattés. elles se seraient flattées.

VOCABULARY

l'Angleterre (f.), *England.*	le manteau, *the cloak, mantle.*
Aristippe, *Aristippus.*	naître, *to be born.*
le bal, *the ball* (dance).	né, *born.*
la bijouterie, *jewellery.*	pourvoir, *to provide.*
chez, *at the house of ;* chez lui, *at home.*	rire, *to laugh.*
demeurer, *to stay, to dwell.*	sortir, *to go out.*
Diogène, *Diogenes.*	soucier, *to cause anxiety to ;* se soucier, *to be anxious.*
fastueux, *arrogant, pompous.*	trouver, *to find.*
l'horloger, *watchmaker.*	l'univers, *the universe.*

Exercise 31

1. La nuit était tout a fait venue. 2. Je ne sais pas de quel point on était parti pour en arriver là. 3. Avez-vous été au bal hier au soir ? 4. Nous n'y avons pas été. 5. Où votre sœur est-elle allée ce matin ? 6. Je ne suis pas encore sorti. 7. Elle est allée le voir hier. 8. Elle est venue à huit heures moins un quart. 9. Ces demoiselles sont-elles nées à Rouen ou à Caen ? 10. L'horloger est-il chez lui ? 11. Non, monsieur, il est allé à son magasin. 12. Il est déjà pourvu d'argent. 13. Elle s'était faite à moi ; je m'étais fait à elle. 14. O Diogène ! si tu voyais ton disciple sous le fastueux manteau d'Aristippe, comme tu rirais ! 15. Ah ! ils s'en soucient bien de l'univers. 16. Voulez-vous que je m'arrête ? 17. Avez-vous trouvé mon père ? 18. Votre père est-il sorti aujourd'hui ? 19. Votre mère est-elle arrivée aujourd'hui ou hier ? 20. Votre frère n'est-il pas parti pour l'Angleterre ?

Exercise 32

1. They were born neither at Rouen nor at Caen, they were born at Strassbourg. 2. Has he been in Paris this year ? 3. Yes, madam, he has been there. 4. Has he bought goods there ? 5. He has bought jewellery there. 6. He has not gone out, he is ill. 7. Is your father at home ? 8. No, sir, he has gone out. 9. When did he go out ? 10. He arrived yesterday, at four o'clock in the morning. 11. Has your cousin been to see his father to-day ? 12. He has left for Paris. 13. No, sir, he has returned to Germany. 14. My sister was at church this morning, and she went to school half an hour ago. 15. How far has your brother gone ? 16. He has gone as far as Paris. 17. How long did you live in London ? 18. We lived there six years. 19. How far did you go ? 20. We went as far as the Champs Élysées.

E. A. B.

GERMAN.—XIV

Nouns (*continued*): **Cases. — Nominative.**—As in English, the nominative is most common as the subject of a verb. However, certain verbs take a nominative complement. These are ſein, *to be*, werden, *to become*, heißen, *to be called*, and other verbs of similar meaning, sometimes called copulatives. Further, such verbs as take a double accusative in the active voice are followed by a nominative when used in the passive voice. Dieſer Mann iſt mein Vetter, *this man is my cousin.*

The verb werden, however, is sometimes followed by the preposition zu with the dative: Sie wurden zu Sklaven, *they became slaves.*

The nominative of address is used just as in English in speaking directly to people or personified things: Lieber Vater, komme doch, *dear father, do come.*

Clearly, if the noun preceded by als or wie is in apposition to a noun in another case, the agreement is likewise unaltered: Er behandelte ihn wie ſeinen eignen Sohn, *he treated him like his own son.*

Genitive with Nouns.—(*a*) Possessive, des Knaben Hut, *the boy's hat.* (*b*) Of origin or cause, das Getöſe des Donners, *the noise of the thunder.* (*c*) Of relation (i.e. the relation in which the one noun stands to the other), die Mutter dieſer Kinder, *the mother of these children.* (*d*) Partitive (i.e. expressing a whole of which the other noun is a part), eins dieſer Bücher, *one of these books.* (*e*) Of quality, material or description, eine Schaar lachender Kinder, *a troop of laughing children;* eine Frau adligen Ranges, *a woman of noble rank.* (*f*) Subjective (describing an action of which the noun in the gen. is the subject), der Götter Neid, *the envy of the gods* (i.e. the envy which the gods feel). (*g*) Objective (describing an action of which the noun in the gen. is the obj.), die Gegner des Königs, *the opponents of the king.*

In practically all cases the preposition von followed by the dat. may be used instead of the gen.; it more or less corresponds to our use of the preposition *of.*

The use of von is especially indicated in the following cases:

1. When the second noun has no termination to indicate its case and no limiting word which would serve as an indication. Der liebliche Anblick von Mädchen und Kindern, *the pleasing sight of girls and children*, but der Anblick vieler Mädchen und Kinder, *the sight of many girls and children*, is admissible, because the limiting word vieler shows the case.

2. When the second noun is the name of a town or country, even when such names admit of declension, though in this case the use of von is not obligatory. Die Kirchen von Paris, *the churches of Paris*, die Einwohner von Berlin, or die Einwohner Berlins, *the inhabitants of Berlin.*

3. When the second noun is preceded by an indeclinable numeral, or a word like allerlei, *of various kinds*, vielerlei, *of many kinds*, or an indeclinable adjective of colour such as roſa, *pink;* Ein Spaziergang von fünf Meilen, *a walk of five miles;* ein Strauß von allerlei Blumen, *a nosegay of various kinds of flowers.*

4. To avoid the use of several genitives together: die Tochter von dem Onkel meines Vaters, *the daughter of my father's uncle.*

After nouns of measure, of extent, quantity, etc., the partitive gen. is not used as it is in English, but the noun is put in apposition instead: eine Taſſe Kaffee, *a cup of coffee;* drei Pfund Zucker, *three pounds of sugar.* But if the second noun has a limiting word before it, then it must be put in the gen.: drei Pfund guten Zuckers, *three pounds of good sugar.*

Instead of the objective gen. a compound noun is often used: Seelengröße for Größe der Seele.

In many cases, too, a preposition followed by a suitable case may be used instead of the obj. gen., and indeed is often necessary to avoid ambiguity: der Gedanke an meine Frau, *the thought of my wife.* Der Gedanke meiner Frau, would convey the idea of *a thought which originated with my wife.*

In dates the month is not put in the gen. after the ordinal, but in the nom. Similarly the uninflected form of the name of the month is always used after the word Monat: Der elfte Mai, *the eleventh of May;* im Anfang des Monats März, *at the beginning of the month of March.*

Pronouns in the gen. case are in one or two cases used partitively: unſer einer, *one of us.* Also after certain verbs combined with nouns: Sie ſind meiner Meiſter geworden, *they got the better of* (mastered) *me.*

Genitive with Adjectives.—A certain number of adjectives govern the gen. They are largely those which are followed in English by *of*, or some other preposition. Ich bin der Sache müde, *I am tired of the thing;* Ich bin des trocknen Tons nun ſatt, *I am sated with the dry tone now;* er iſt der Ehre nicht würdig, *he is not worthy of the honour.*

Among the commonest of these adjectives are those already mentioned and voll, *full;* bewußt, *conscious;* fähig, *capable;* gewiß, *sure;* ſchuldig, *guilty;* überdrüſſig, *tired* (mentally); unwürdig, *unworthy.*

Genitive with Verbs.—A good many verbs govern a gen. as well as the acc. of the direct object. These are verbs of removing, separating, depriving, accusing, convicting, admonishing, assuring, and so on: er hat ihn einer großen Laſt entledigt, *he has relieved him of a great burden;* ſie klagten mich des Betrugs an, *they accused me of fraud.*

An even greater number of reflexive verbs govern a gen. in addition to their reflexive object. These are of similar meaning to those mentioned above, also verbs of remembering, verbs expressing an emotion and others: Er freut ſich ſeiner Jugend, *he takes pleasure in his youth;* Ich erinnere mich der Sache genau, *I remember the affair exactly.*

A certain number of verbs govern a direct object in the gen.: er bedarf der Hülfe, *he needs help;* Sie ſpotteten des Dichters, *they mocked the poet.*

Most of the above verbs can take an acc. instead of a gen. or may be followed by a preposition: Ich warte deiner, or ich warte auf dich, *I am waiting for thee.*

Adverbial Uses of the Genitive.—Nouns may be used with or without adjuncts in the gen. as adverbial expressions: Morgens, *in the morning;* Tags über, *during the day;* Nachts, *at night;* Anfangs, *at the beginning;* jedenfalls, *certainly;* er ging ſchnellen Schrittes vorüber, *he passed with a quick step;* geh' deines Weges, *go thy way;* ſie waren guter Dinge, *they were of good cheer.*

VOCABULARY

Fiſcher, s.m.1, *fisherman.*
rauſchen, w., *to murmur, roar,* or *move with a rushing sound.*
ruhevoll, *calm.*
lauſchen, w., *to listen.*
empor, *upwards.*
feucht, *damp, watery.*
hervor, *forth.*
Brut, w.f., *brood.*
Liſt, w.f., *cunning.*
Glut, w.f., *glow, fierce heat.*
Grund, s.m.2, *bottom.*
geſund, *healthy, whole.*
lieb, *dear.*
Mond, s.m.2, *moon.*
Welle, w.f., *wave.*
Geſicht, s.n.3, *face* or *form.*
herkehren, w., *to return.*
ziehen, s.3c (pret. zog, past part. gezogen), *to draw, drag.*
Waſſer, s.n.1, *water.*
ſchwellen, s.3e, *to swell.*
Angel, w.f., *fishing rod.*
kühl, *cool.*
ſich teilen, w., *to part.*
bewegen, w., *to move.*
Weib, s.n.3, *woman.*
locken, w., *to entice.*
Witz, s.m.2, *wit, ingenuity.*
Tod, s.m., *death.*
wohlig, *comfortable, cosy.*
herunterſteigen, s.3b, *to descend.*
laben, w., *refresh.*
Sonne, w.f., *sun.*
Meer, s.n.2, *ocean.*
atmen, w., *to breathe.*
doppelt, *double.*
verklären, w., *to transfigure.*
Angeſicht, s.n.3, *countenance.*
Tau, s.m., *dew.*
nackt, *naked.*
wachſen, s.2b, *to grow, wax.*
Gruß, s.m.2, *greeting.*
ewig, *eternal.*
netzen, w., *to wet.*
Fuß, s.m.2, *foot.*
ſehnſuchtsvoll, *full of yearning.*
geſchehen, s.2a, *to happen.*
hinſinken, s.1a, *to sink down.*

Exercise 35

Der Fiſcher

Das Waſſer rauſcht[1], das Waſſer ſchwoll,
Ein Fiſcher ſaß daran,
Sah nach[2] dem Angel[3] ruhevoll,
Kühl bis[4] ans Herz hinan.
Und wie er ſitzt und wie er lauſcht,
Teilt[5] ſich die Flut empor:
Aus dem bewegten[6] Waſſer rauſcht[7]
Ein feuchtes Weib hervor.

Sie ſang zu ihm, ſie ſprach zu ihm:
Was[8] lockſt du meine Brut
Mit Menſchenwitz[9] und Menſchenliſt[9]
Hinauf in Todesglut?[10]
Ach, wüßteſt[11] du wie's Fiſchlein[12] iſt
So wohlig[13] auf dem Grund,
Du ſtiegſt[14] herunter wie du biſt,
Und würdeſt erſt[15] geſund.

Labt ſich die liebe Sonne nicht,
Der Mond[16] ſich nicht im Meer?
Kehrt wellenatmend[17] ihr Geſicht
Nicht doppelt ſchöner her?
Lockt dich der tiefe[18] Himmel nicht,
Das feuchtverklärte[19] Blau?
Lockt dich dein eigen Angeſicht
Nicht her in ew'gen Tau?

Das Waſſer rauſcht', das Waſſer ſchwoll,
Netzt'[20] ihm[21] den nackten Fuß;
Sein Herz wuchs ihm ſo ſehnſuchtsvoll,
Wie bei der Liebſten[22] Gruß.
Sie ſprach zu ihm, ſie ſang zu ihm;
Da war's um ihn geſchehn;[23]
Halb zog ſie ihn, halb ſank er hin.[24]
Und ward[25] nicht mehr geſehn.[23]

Johann Wolfgang von Goethe.

NOTES:

(1) rauſcht, the **e** of the preterite termination **te** is omitted on account of the metre. (2) nach—take this as a separable prefix with ſehen, i.e. nachſehen, *to look after.* (3) Angel, this will be found as a fem. noun in the vocabulary: that is its gender in modern German, but when Goethe wrote the above ballad at the end of the 18th century its gender was usually mas. (4) bis ans Herz hinan, *right up to his heart,* or, as we should rather say, *right into the depths of his heart.* (5) ſich empor teilen, *to part upwards,* i.e. the water parts so that the waves appear to be piled up on either side of the cleft. (6) bewegt, *moved* and therefore turbulent. (7) rauſcht, hervorrauſchen, *to move,* or *step forth* with a rustling sound. (8) was, in the sense of warum, *why?* (9) Menſchenwitz, a compound, literally *wit of mankind;* Menſchenliſt is a similar compound. (10) Todesglut, *death-bringing* or *fatal heat,* because the heat and drought of dry land is fatal to fish. (11) wüßteſt du, the past conjunctive with inverted order, is equivalent to a conditional, just as in English *were he here* is equivalent to *if he were here.* (12) Fiſchlein is dative case. (13) wohlig—there is a common impersonal expression, es iſt mir wohl, or mir iſt wohl, which means *I*

feel well, comfortable; this construction with wohlig is exactly the same. (14) du ſtiegſt herunter, ſtiegſt stands for ſtiegeſt, the past conjunctive, *thou wouldst descend;* herunter, her, has its usual meaning of *hither*, i.e. towards the speaker; the mermaid speaks from the point of view of one who lives at the bottom of the sea. (15) erſt has the force of *for the first time.* (16) der Mond—supply labt, again, before this. (17) wellenatmend, literally *breathing waves.* (18) tiefe Himmel, *deep sky* as reflected in the water. (19) feuchtverklärt, *transfigured* by the waters. (20) netzt, *see* (1). (21) ihm, dative of interest. (22) Liebſten, die Liebſte, literally *the most beloved*, i.e. his lady love. (23) geſchehn for geſchehen (the past part.)—the contraction is made on account of the metre. Similarly with geſehn for geſehen: es iſt um ihn geſchehen, an idiom meaning *he is undone, he is lost.* (24) hin—the poet speaks here from the point of view of the fisherman, therefore hin, i.e. in a direction away from where he is at the time. (25) ward, the older form of the preterite of ſein.

VOCABULARY

conjurer, Zauberer, s.m.1.
by chance, zufällig.
alas, ach.
what, was . . . für.
creature, Weſen, s.n.1.
undone, verloren.
have recourse to, ſich halten an, gov. acc.
sincerely, aufrichtig.
fail, verſagen, w.
reduce, bringen . . . an, gov. acc.
apply to, ſich wenden an, gov. acc.
overspread, überziehen, s.3c (insep.).
customer, Kunde, w.m.
none, Niemand.
in vain, umſonſt.
fire, Feuer, s.n.1.
pin, Nadel, w.f.
single, einzig.
oblige (force), zwingen, s.1*a*.
calling, Beruf, s.m.2.
despise, verachten, w.
tailor, Schneider, s.m.1.
converse, ſich unterhalten, s.2*c* (insep.).
cry, ausrufen, s.2*d* (sep.).
unhappy, unglücklich.
clothes, Kleider, s.n.3.
trade, Handwerk, s.n.2.
indeed, in der Tat (die Tat), w.f.
pity, bedauern, w.
trick, Kunſtſtück, s.n.2.
however, dennoch.
beggary, Bettelſtab, s.m.2.
relieve, helfen, s.1*c*., gov. dat.
famine, Hungersnot, s.f.
make shift to live, ſich mühſam ernähren, w.
throw away, wegwerfen, s.1*c* (sep.).
promise, verſprechen, s.1*c*.
eat, eſſen, s.2*a*.
vomit, ſpeien, s.3*b*.
till, bis.
beg from, anbetteln, w (sep.).
formerly, früher.

Exercise 36

THE CONJURER AND THE TAILOR

A conjurer and a tailor once happened[1] to converse together[2]: "Alas!" cries the tailor, "what an unhappy poor creature am I? If people[3] take it into their heads to live without clothes, I am undone[4], I have no other trade to have recourse[5] to."

"Indeed, friend, I pity you sincerely," replies the conjurer; "but thank heaven[6], things[7] are not quite so bad with me; for if one trick should fail, I have a hundred tricks more for them yet[8]. However, if at any time you are reduced to beggary, apply to me, and I will relieve you."

A famine overspread the land; the tailor made shift to live, because his customers could not be without clothes; but the poor conjurer with all his hundred tricks, could find none that had money to throw away; it was in vain[10] that he promised to eat fire, or to vomit pins; no single creature would relieve him, till he was at last obliged to beg from the very[11] tailor whose calling he had formerly despised.

Oliver Goldsmith.

NOTES:

(1) Translate: *conversed by chance.* (2) Together, omit this in translating. (3) People . . . heads, wenn es den Leuten einfallen ſollte, i.e. if it should occur to people. (4) Inverted order because the dependent clause comes first. (5) Translate: to which I can have recourse. (6) Thank heaven, dem Himmel ſei Dank or Gott ſei Dank. (7) Things . . . me, translate it does not stand so badly with me. (8) *See* (4). (9) Translate: yet a hundred tricks for them. (10) Translate: in vain he promised. (11) The very, translate: the same.

Key to Exercise 33

For the first time I had heard at the Gewandhaus in Leipzig the great Symphony in C minor by Ludwig van Beethoven. Quite intoxicated still by this flood of harmony, which had rushed through my whole soul, I hurried down the street, without noticing the rain with which in a lukewarm fashion the month of March announced the approaching spring. "And this great master of music (tones) is my contemporary," said I, "and should I not have the satisfaction of pressing the living man's hand as an expression of thanks?" With this thought in my mind I stepped into my lonely room. "A letter from Vienna," cried my servant. I recognised by the seal and superscription that it came from my friend Robert who was so fond of travel, from whom I had heard nothing for a long time. I opened the letter and found in it only the words:

"'There's only one imperial city
There's only one Vienna.'

John, our roaming musician, is also here (there). Do come." Nothing more in the whole letter, but this summons decided (about) me. I was still young, joyful, quick and resolute, I was still an unbridled (free) steed that with flying mane runs races (wagers) with the wind, and in sport pursues the birds, and I made use of my freedom. "Two friends and Beethoven into the bargain in Vienna," I exclaimed, and continuing to sing the song:

"O that must be splendid,
I should like to go there."

On the third day following I was rolling in a cabriolet, on the mail coach down into blue Bohemia, before me the first lark of spring warbling in the grey March sky, on and on, till at last I sat in the evening at the fireside with my two friends in the vegetable market in Vienna.

Key to Exercise 34

Es waren jedoch Widerſprüche in dem Charakter dieſes liſtigen und tüchtigen Fürſten; denn die menſchliche Natur iſt ſelten einförmig. Obgleich er ſelbſt der falſcheſte und unaufrichtigſte der Menſchen war, entſprangen einige der größten Fehler ſeines Lebens einem zu vorſchnellen Vertrauen in die Ehrenhaftigkeit und die Redlichkeit andrer. Wenn dieſe Fehler vorkamen, ſcheinen ſie einem überfeinen Syſtem der Politik entſprungen zu ſein, welches Ludwig veranlaßte den Schein eines zweifelfreien Vertrauens in denjenigen anzunehmen, die zu überliſten ſein Beſtreben war; denn in ſeinem allgemeinen Benehmen, war er ſo eiferſüchtig und argwöhniſch wie irgend ein Tyrann der jemals lebte.

M. A. L.

Continued from Vol. II., page 486.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

SOUTH AMERICA.—I

SOUTH AMERICA may be roughly divided into four physical divisions:

(1) The great chain of the Andes, extending from the south of the continent to its northernmost point.

(2) The Amazon Basin.

(3) The plateau of Brazil.

(4) The Estuary of the La Plata.

The Andes serve as the spine of South America. It is the peculiar situation of this great range, parallel with the western coastline, that accounts for the easterly flow of all the mighty streams of the continent to the Atlantic, and the phenomenal paucity in rivers that is one of the features of the Pacific shore. It is owing to the influence of this chain, too, that is due the aridity of such lengthy stretches of the Pacific littoral.

The Andes

The general tendency of the Andes is to rise in height as the range runs towards the centre from both the north and the south of the continent. The loftiest peak of all is Aconcagua which, rising high over the railway connecting Argentine and Chile, attains to a height of over 22,800 feet. In its neighbourhood are other tremendous mountains such as Tupungato (22,000 feet), and Cerro del Mercedario, which exceeds this by a few hundred feet.

The gigantic scale on which these mountains of the Andes rise may be judged from the astonishing fact that in the Republic of Ecuador alone are no fewer than seventeen summits which exceed 15,000 feet, the magnificent volcano of Chimborazo topping the list with its altitude of 20,498 feet.

The highlands of eastern Venezuela and of the Guianas are practically the only heights in South America which are unconnected in any way with the great Cordillera of the Andes. As might well be expected, the fauna and flora of the main Andes range cannot compare either in number or variety with that which is to be met with elsewhere in the continent. Of the few birds which are characteristic of the heights the most important is the condor. Other animals which are typical of the great chain are the llama, guanaco, vicuña, and alpaca.

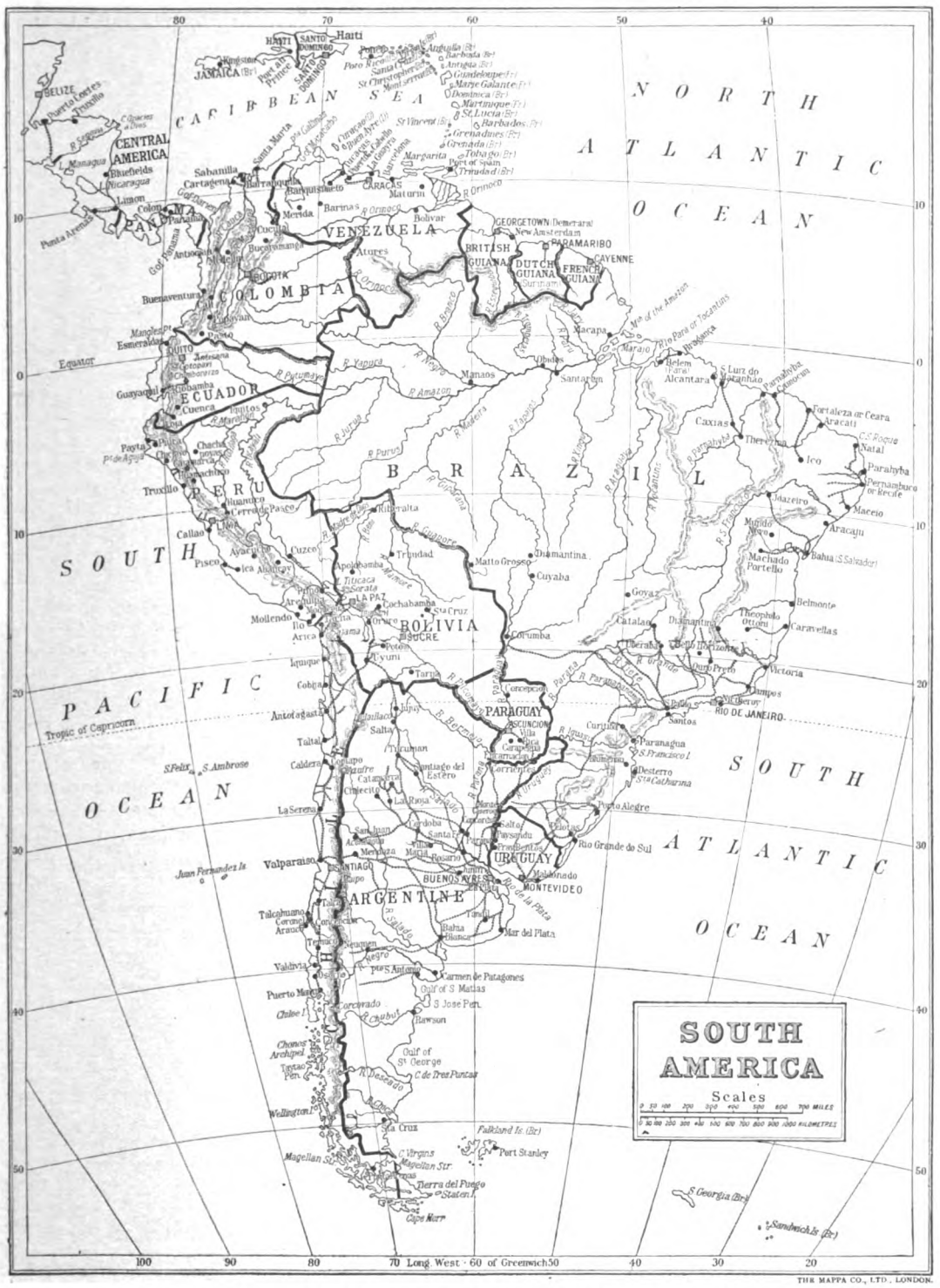
The higher slopes and plateaux of the main range are mere barren, windswept, and snow-covered areas of desolation. Beneath these the question of flora resolves itself into one of altitude, the first growths to be met with on a descent from the heights being barley, wheat, and other European cereals, while as the descent continues, these give way to maize, vines, oranges, peaches, and similar fruits. Then, in the tropical regions, the final descent reveals the banana and its corresponding fruits, and all the wealth of the virgin forests.

A feature of these Andean countries, it may be said, is the quite unusual altitude at which the majority of the capitals are situated. Thus La Paz, the capital of Bolivia, stands at a height of 12,226 feet above sea level; Quito, the capital of Ecuador, is about 3,000 feet less in altitude, while Bogotá, the capital of Colombia, lies 8,678 feet up in the mountains.

Basin of the Amazon

In approaching the Amazon basin we arrive at a species of country which, compared with the Andes, is in every respect at the opposite end of the physical pole. The two areas are utterly distinct, not only in landscape, climate, fauna and flora, but also in aborigines, for whereas the Andes heights were wont to shelter the two civilised empires that South America has known in the pre-Spanish age, the Incas and the Chibchas, the forest plains of the Amazon have never held any humanity of a higher order than the tribes of quite crude Indians who existed, and many of whom still exist, by hunting and fishing.

The area of the Amazon basin which contains the largest area of unexplored



The main physical features of South America are the great Brazilian plateau, the basins of the Amazon and Paraguay, and the Andes—the spine of the continent—which, owing to their peculiar situation, parallel to the west coast, account for the easterly flow of all the great rivers.

forest country in the world includes the entire northern half of Brazil; the eastern districts of Bolivia, Peru, and Ecuador; and smaller parts of even Colombia and Venezuela. It contains nearly thirty thousand miles of navigable waterways, and the navigable length of the main stream for ocean-going steamers is two thousand five hundred miles.

The principal tributaries which flow into the Amazon from the south side are the Tocantins, Purus, Jurua, Madeira, Tapajos, and Xingu. From the north the chief affluents are the Putumayo, Japura, Negro, and the much smaller Trombetas. One of the most rapid and impetuous of all these great rivers is the Madeira. This contains a great number of falls, and a railway has now been constructed to effect communication with the respective streams above and below these.

Flora and Fauna

Until recently the climate of the Amazon basin has borne the evil reputation of being one of the worst in the world. Modern science, however, has already begun to alter this situation for the better, and there is no doubt that the day will come when the towns of this great basin will be as sanitary as that of Panama at the present time.

The flora of the Amazon comprises many varieties of magnificent forest trees, the timber of many of which serves for cabinet woods. There are, in addition, dye-woods, medicinal growths, and others such as the vegetable ivory, and similar tropical products. The most valued tree of all for commercial purposes is, of course, the rubber tree, which has been responsible for a great part of the traffic on the waters of the Amazon to-day.

The fauna of the Amazon basin includes practically all those specimens to be met with in the lowlands of tropical South America. Some of the chief animals are the jaguar, puma, wild cat, tapir, many varieties of monkeys, ant-eater, paca, coati, capibara, peccary, armadillo, sloth, and numerous others of the land creatures. The birds include macaws, parrots, toucans, vultures, goatsuckers, curassows, kingfishers, trogons, humming-birds, and an almost innumerable number of water birds.

The greatest snakes are the boa-constrictor and the anaconda.

The waters of the Amazonian streams teem with fishes and with other denizens, some of which attain to a great size. One of the most notable of these latter is the manatee, a fresh water mammal. Other notable river creatures are the alligator, sting-ray, electric eel, turtle, and a small but extremely ferocious fish known as the piranha.

Compared with the Amazon basin, that of the Orinoco is, of course, of small account in the way of area, although in Europe it would be regarded as a river system of the very first order. Its territory differs considerably from that of the typical Amazon country; for although the estuary is low and swampy, the land in general through which the Orinoco and its tributaries pass is considerably more mountainous than that traversed by any other than the head waters of the Amazon.

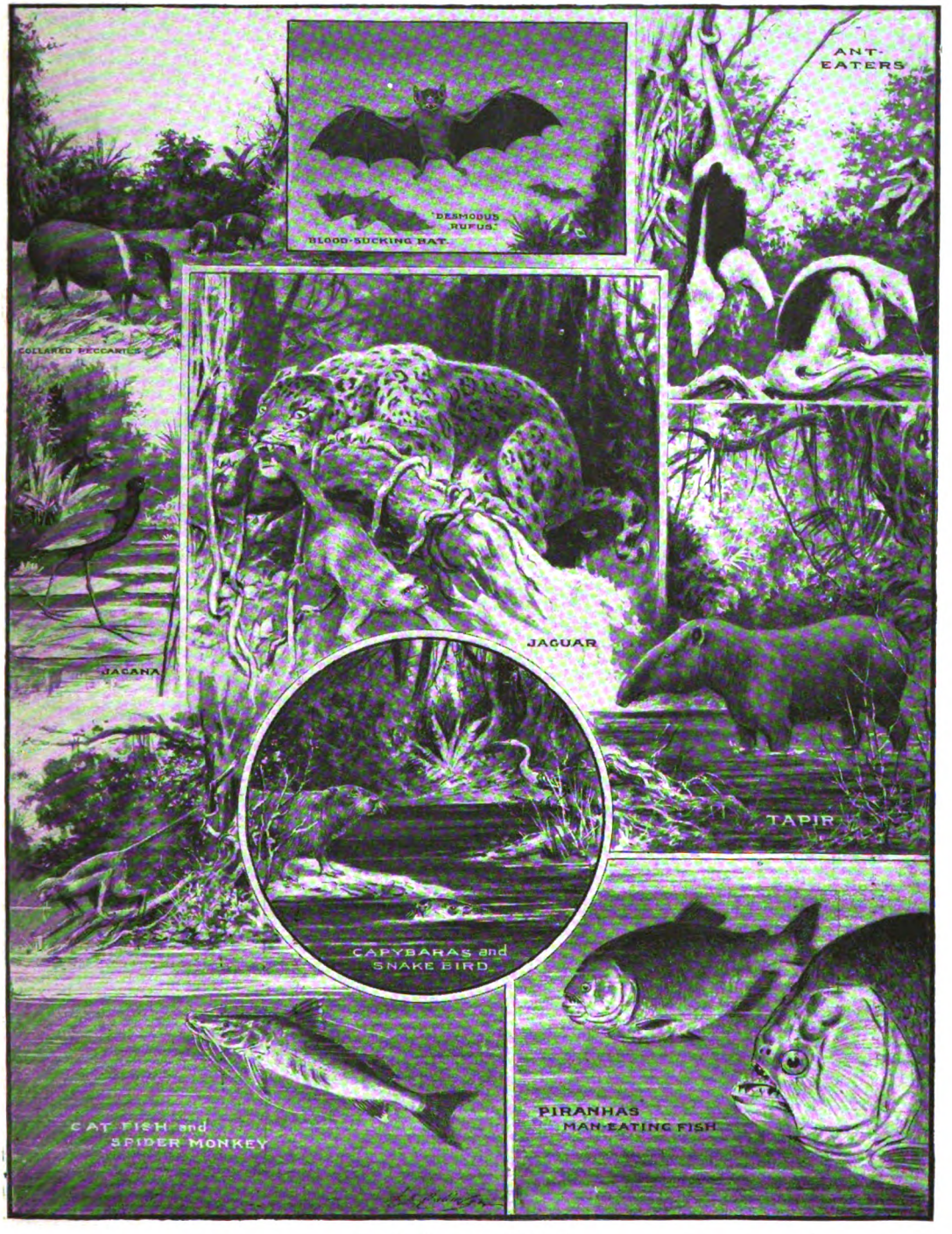
The Plateau of Brazil constitutes the uplands which occupy the entire interior of the country from the basins of the Amazon and the La Plata system to the Atlantic coast. This plateau is in the shape of a rough triangle which tapers down to the Republic of Uruguay in the south. The average altitude of the great plateau is about two thousand five hundred feet. The climate is temperate and salubrious.

The typical country of the Plateau of Brazil is the *Sertao*—a great area containing much rough pasture interrupted by stony and cactus-covered districts—in the midst of which occur the tracts of *Serra*. In these latter flourish such growths as coffee, tobacco, and sugar cane.

La Plata Estuary

The Estuary of the La Plata comprises a more varied set of regions which, did space allow, might well be subdivided into various lesser districts. The northern part of this is of a tropical nature, for the head waters of the Paraguay, the chief stream of the La Plata system, rise within a few score miles of those of the southern affluents of the Amazon.

On the right bank of the Paraguay is the Chaco, or Gran Chaco, a curious, flat stretch of country, wooded in parts, swampy in others, that extends from Bolivia in the north through Paraguay to Argentina in the south, but which never occurs on the left bank. The country on the right bank of the Paraguay River is, generally speaking, undulating. In the Republic of Paraguay the soil of the left bank is extremely fertile, and as the lower reaches of the river are approached the banks become more populous and more closely cultivated. That part of Central and Southern Paraguay, indeed, which lies to the east of the river is frequently called the Garden of South America.



FAUNA OF BRAZIL.

In the Amazon basin thrive practically all those specimens which may be found in the lowlands of tropical South America. Among the denizens of Brazil, not shown above, should be included that monster snake, the boa-constrictor, and the anaconda.

To the north of the Estuary of the Rio de la Plata extend the rolling hills of Uruguay, which may be said to comprise the southern end of the Brazilian Plateau; but to the south and west of this are the great alluvial pastoral plains of Argentina, that hold some of the richest land in the world. To the south of this again extend the rolling hills and rather lowly mountains of Patagonia.

The fauna of these regions is in many respects similar to that of Brazil, save that the more tropical varieties of birds, beasts, and fishes are not to be met with. The plains, moreover, known as the Pampas have several species which are peculiar to them, such as the ostrich, vizcacha, or prairie dog, the nutria, a large rodent, and some other kinds.

The flora of the northern part of the basin of the Rio de la Plata closely resembles that of southern Brazil. The alluvial plains of Argentina, however, are almost entirely devoid of any indigenous trees. In the Patagonian territories the vegetation is essentially that of the cold climates, and here such typically European trees as the beech and oak flourish.

The rivers south of the La Plata estuary are relatively scarce. The chief of these are the Colorado, Negro, and Chubut. In these regions, it may be said, there still survive a certain number of those Patagonian Indians so justly famed for their great stature. These are now semi-civilised, but continue to exist by hunting and fishing. To the south of this territory, again, the canoe Indians of Tierra del Fuego represent a very low type of humanity.

Political Divisions

Politically, South America is divided into ten states, and three colonies. The ten states are the Republics of Venezuela, Colombia, Ecuador, Peru, Bolivia, Brazil, Paraguay, Chile, Argentina, and Uruguay. The three colonies are the British, Dutch, and French Guianas.

Spanish is the official language in nine out of the ten states, the exception being the great Republic of Brazil, in which the speech is Portuguese. A certain number of the states, however, are bilingual.

The following are the capitals of the various states: Caracas, the chief town of Venezuela, is noted as a centre of learning, a reputation which it may be said to share with Santa Fé de Bogotá, the chief town of Colombia.

Quito and La Paz, the capitals respectively of Ecuador and Bolivia, are chiefly notable for their high altitude, which is remarked on in another place. Lima, the capital of Peru, the old viceregal centre of the days of the Spanish empire, is an imposing city of much historical interest, while Santiago, the capital of Chile, is a finely laid out town situated amid delightful surroundings in the lower Andes.

Buenos Aires, the capital of Argentina, is a really great city, possessing tube railways and many other facilities of the kind, with a population which exceeds one and a quarter millions. Uruguay's chief town, Montevideo, is a smaller, but very modern centre, while Asuncion, the river capital of Paraguay, on the other hand, still retains much of the old colonial atmosphere that makes it a pleasant but somewhat stagnant spot.

Finally, Rio de Janeiro, the capital of Brazil, situated on the shores of its beautiful mountain-fringed bay, has justly earned the reputation of being one of the finest cities in the world, having been planned practically entirely afresh and provided with magnificent avenues and buildings within the last twenty years.

South American Republics

The inhabitants of South America are frequently referred to as a whole, as though the entire number of its inhabitants constituted a single race. This impression, however, is entirely erroneous; for there are as many distinctions between the inhabitants of temperate and of tropical South America as there are between those of Europe and Africa.

The republics, which, although they contain a certain number of Indians, fall within the "white" category, are those of Argentina, Chile, and Uruguay. The great Republic of Brazil is rather differently placed in this respect. Its governmental centre and southern provinces are "white," but it possesses a large Indian and negro population which, in the centre and north, very largely outnumbers the other, and here the intermixture of the white with the other races has been very marked.

The racial situation in Paraguay and Peru is similar to that of Brazil, with the exception that in these other countries the negro element is practically non-existent. In Bolivia, Ecuador, Colombia, and Venezuela, however, the Indian element predominates to such a degree that it is extremely rare to meet with a person of unmixed European blood.

W. H. K.

Continued from Vol. II., page 493.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A.[Lond.]).

ARITHMETIC.—XVII

124.—Interest is a sum of money paid for the loan or use of some other sum of money, lent for a certain time at a fixed rate.

A **percentage** of the sum lent is usually charged as interest—that is, so much is charged per year for every £100 lent. This sum is called the **Rate per Cent.** per annum.

Thus, if a man borrows at 5 per cent. per annum, for every £100 he has borrowed he has to pay £5 each year. The sign % stands for "per cent."

The sum of money lent is called the **Principal.**

The principal + interest is called the **Amount.**

When the interest is calculated only on the original sum lent, it is called **Simple Interest.**

When the interest, instead of being paid by the borrower when it falls due, is added to the principal, and the interest for the next period is reckoned on the original principal and the interest which has been added, i.e. on the amount at the end of the first period, the money is said to be lent at **Compound Interest.**

125.—Simple Interest.

Example:—

Find the simple interest on £320 15s. for 2 years 35 days at $4\frac{3}{4}$ %.

Principal = £320 15s. = £320·75.

$$\text{Interest} = £320{\cdot}75 \times \frac{19}{4 \times 100} \times 2\frac{7}{73}$$

$$= £3{\cdot}2075 \times \frac{19 \times 153}{4 \times 73} = £{\cdot}801875 \times \frac{2907}{73}$$

```
= £      ·801875
           2907
         5613125
        7216875
       1603750
73 )2331·050625( £31·9322
     141
      680
       235
        160
         146
          ...
```

£31·9322 = **£31 18s. 8d.**

126.—We may easily arrive at a formula connecting Simple Interest, Principal, Rate per cent., Time and Amount.

Let Simple Interest be I.
,, Principal ,, P
,, Rate per cent. ,, r.
,, Time (in years) ,, t.
,, Amount ,, A.

Then $I = P \times r \times t$ and $A = P + I = P + Prt = P(1 + rt)$

hence, given three of these quantities we can find the fourth.

Examples:—

(1) At what rate per cent. will £350 produce £42 interest in 3 years?

$P = 350,\ t = 3,\ I = 42$

$$I = P \times r \times t \therefore r = \frac{I}{P \times t} = \frac{42}{350 \times 3} = \frac{1}{25}$$

$r = \frac{1}{25}$ of £100 = £4

$\therefore$ rate % = **£4.**

(2) On what sum will the simple interest for 4 years at $2\frac{1}{2}$ % be £37?

$$I = 37,\ r = \frac{2\frac{1}{2}}{100} = \frac{1}{40},\ t = 4$$

$$I = P \times r \times t \therefore P = \frac{I}{r \times t} = \frac{37}{\frac{1}{40} \times 4} = 370$$

$\therefore$ the sum is **£370.**

(3) In what time will £1,275 amount to £1,549 11s. at $3\frac{4}{5}$ %?

$$P = 1275,\ r = \frac{3\frac{4}{5}}{100} = \frac{19}{500},\ A = 1549\tfrac{11}{20}$$

$$A = P(1 + rt) \therefore Prt = A - P \therefore t = \frac{A - P}{Pr}$$

$$= \frac{274\frac{11}{20}}{1275 \times \frac{19}{500}} = \mathbf{5\tfrac{2}{3}\ years.}$$

127.—Compound Interest.

Since, when money is lent at Compound Interest, the interest due at the end of the first period is added to the principal, and the interest for the second period is calculated on the sum of these two, we have the following formulæ:

$P_1 = P_o + r P_0 = P_0(1 + r)$

$P_2 = P_1 + rP_1 = P_1(1 + r)$

.....

$A = P_n = r P_{n-1} + r P_{n-1} = P_{n-1}(1 + r)$

Where Po = original sum, P_1 = amount at end of first period, i.e. = second principal, P_n = nth principal = A = amount after n periods of time, and r = rate per cent. of interest paid.

The following examples will show the best way to deal with the calculation of Compound Interest.*

Examples:—

(1) Find the Amount and the Compound Interest of £480 for 3 years at 5 %.

£480 = 1st Prin. = P_o
24 = 1st year's interest
——
£504 = 2nd Prin. = P_1
25·2 [= 2nd year's interest
——
£529·2 = 3rd Prin. = P_2
26·46 = 3rd year's interest
——
£555·66 = Amount at end of 3 years

∴ Amount = £555 13s. 2d., and the Compound Interest = A — P_o = **£75 13s. 2d.**

In calculating the interest for each year we multiply by 5 and move the figures 2 places to the right, since we must divide by 100.

(2) Find the amount of £385 15s. 3d. for 2 years at 3¼ % Compound Interest.

£385 15s. 3d. = £385·7625

rate = 3¼% = $\frac{13}{4}$ % ∴ we multiply the principal by 13 and divide by 400 to calculate the interest.

£385·7625 = P_o
13
400) 5014·9125
12·537281 = Interest for first year
385·7625
398·299781 = P_1
13
400) 5177·897153
12 944743 = Interest for 2nd year
398·299781
£411·244524 = Amount
= **£411 4s. 11d.** approximately.

(3) Find to the nearest penny the Compound Interest on £500 for 2½ years at 2½ %, the interest being payable half-yearly.

2½ % for 1 year = 1¼ % for a half year and 1¼ % = $\frac{1}{80}$

∴ we calculate the half-yearly interest by dividing the principal by 80.

£500 = P_o
6·25 = Interest for first half-year
£506·25 = P_1
6·328 = Interest for 2nd half-year
£512·578 = P_2
6·4072 = Interest for 3rd half-year
£518·9852 = P_3
6·4873 = Interest for 4th half-year
£525·4725 = P_4
6·5684 = Interest for 5th half-year
£532·0409 = Final Amount
£500 = P_o
£ 32·0409 = **£32 0s. 10d.** = total interest for 2½ years.

* In the courses on Algebra and Logarithms, we shall give formulæ which greatly facilitate such calculations.

(4) What sum will amount to £2,615 4s. in 4 years at 3 % Compound Interest?

First find what sum £100 will amount to in 4 years at 3 % Compound Interest.

This is £112·5509

Then by Unitary Method

£112·5509 = sum to which £100 will amount
£1 = " " " £$\frac{100}{112·5509}$ " "
2615·2 = " " " £$\frac{100 \times 2615·2}{112·5509}$ "

and £ $\frac{100 \times 2615·2}{112·5509}$ = **£2323 11s. 5d.** to the nearest penny.

128.—Present Worth and Discount.

Since interest can always be obtained on money, the actual cash value of a given sum of money due a certain time hence at a given rate of interest is that sum which would in the same time and at the same rate of interest amount to the given sum.

This actual cash value is called the **Present Worth.**

The **Theoretical Discount** on a sum is the interest on the Present Worth of that sum, reckoned from the present time to the date on which the sum falls due. This theoretical discount, however, is not used in business; instead of this, **Banker's Discount** is used as being more practical. This is the interest calculated on the actual sum (instead of on its Present Worth for the given time).

129.—Present Worth.

If S be the given sum, t the time and r the rate per cent. simple interest, then if P be the Present Worth, we know that $S = P + Prt = P(1 + rt)$

$$\therefore P = \frac{S}{1 + rt}$$

Examples:

(1) Find the Present Worth of £1,025 13s. 4d. due 5¼ months hence at 3 % Simple Interest.

$S = £1025\frac{2}{3}$, $t = \frac{21}{48} = \frac{7}{16}$ year, $r = \frac{3}{100}$

$$P = \frac{S}{1 + rt} = £\frac{1025\frac{2}{3}}{1 + \frac{7}{16} \times \frac{3}{100}} = £\frac{3077 \times 1600}{3 \times 1621}$$

= **£1012 7s. 7d.** approximately.

(2) Find the Banker's Discount on £250 at 5 % 6 months before the sum is due.

Discount = £250 × $\frac{5}{100}$ × ½ = **£6 5s.**

130.—This discount is chiefly used in connection with Bills. **Bills** are promises to pay a certain sum of money on a specified date, stated on the Bill.

NOTE: This must not be confused with the bill or account sent in by a tradesman for goods.

131.—Trade Discount.

Some tradesmen will deduct something from the price of goods if cash is paid for them. This is also called Discount, but unlike Banker's Discount, it is independent of time.

Thus: A tradesman gives 5 % discount for cash. How much will this amount to on a bill of £12 17s. 6d.?

5 % = $\frac{5}{100}$ = $\frac{1}{20}$

$\frac{1}{20}$ of £12 17s. 6d. = **12s. 10½d.**

132.—Stocks and Shares.

A great many businesses are carried on as Limited Liability Companies. When this is the case, a certain sum of money is decided on as being necessary to carry on the business; this sum is called the **Capital,** and it is divided up into **Shares.** Shares differ in amount, but are usually (in this country) £1, £5 or £100. The people who buy the shares are called **Shareholders;** once they have paid for their shares in full, they have no further liabilities—that is to say, should the business fail, they cannot be called upon to supply the deficit.

Shareholders are supplied with Certificates which show their right to the property or investment. These Certificates bear the seal of the company, no stamp being necessary. The numbers of the shares, their nat ure, and the amount paid up will be clearly stated. It may be interesting to note that the issue of certificates was not compulsory until the passing of the Companies Act in 1907, though it was the usual practice of companies to issue them on their own account.

If a certificate is lost the shareholder is usually granted a new one if he gives a proper indemnity.

Very often, when shares are issued, those who take them up (or buy) them are only asked to pay a part of the full amount, and are then liable to pay the rest either on a fixed date or when called upon to do so. Either yearly, or half-yearly, or quarterly, the profits derived from the business are divided among the shareholders. These profits are called **Dividends,** and are either so much per share or so much per cent.

Dividends are only paid upon the amount of each share which has been paid up. Sometimes only part of the profits are so divided and the rest is either placed in a **Reserve Fund** to be used in case of emergencies, or else is carried forward and distributed at the next payment of dividends.

Shares are bought and sold upon the Stock Exchange. Obviously the shares of a company which pays good dividends will be more in demand than those of another which pays little or no dividend, and consequently some shares will fetch a higher price than their nominal value (of £1, £5, etc.), while others will fetch a lower price.

Shares are of different kinds, and one and the same company may issue these different kinds of shares.

Debenture Shares have a fixed amount of interest guaranteed, and for these the company pledges its assets as security.

Preference Shares have the first claim to any dividend after the interest on the debentures has been paid. Their dividend is usually limited to a fixed amount, and sometimes it is cumulative, i.e. if the profits are insufficient one year to pay the fixed dividend, the deficit must, if possible, be made up in succeeding years.

Ordinary Shares receive dividend after the interest on debentures and the dividends on preference shares have been paid. Shares are said to be **below par** or **at a discount** when they are sold for less than their nominal value, and are said to be **above par** or **at a premium** when they are sold for more than their nominal value. Shares which can be bought or sold at their nominal value are said to be **"at par."** Sometimes the capital of a company is not divided into shares of a definite amount; in this case it is called **Stock.** Money borrowed by any government or municipality at a fixed rate of interest is also called **Stock.**

Any amount of Stock may be bought or sold, whereas only a whole number of shares can be dealt with.

Exercise 43

Find the Simple Interest on:

(1) £85 for 3 years at 5 %.
(2) £475 for 6 years at 2½ %.
(3) £118 2s. 4d. for 2½ years at 3 %.
(4) £375 for 1 year and 10 months at 3½ %.

Find the Amount of

(5) £1534 6s. 3d. for 1⅝ years at 3¼ %.
(6) £110 for 7 months at 3¾ %.
(7) £160 7s. 6d. for 2 years 35 days at 4¾ %.
(8) £17 5s. from June 12 to September 23, at 4½ %.
(9) If the Simple Interest on £265 8s. 9d. for 11 years be £145 19s. 9¾d., find the Simple Interest on £1,178 11s. 8d. for 6 years at the same rate.

Exercise 44

Find the Compound Interest and the Amount of

(1) £800 in 3 years at 3¾ %.
(2) £230 15s. for 3 years at 5 %.
(3) £845 14s. 6d. for 2¼ years at 1¼ %.
(4) £130 in 3 years at 4 % (interest payable half-yearly).
(5) £360 12s. 6d. for 2 years at 3½ % (interest payable half-yearly).
(6) What is the difference between the Compound and the Simple Interest of £1,875 11s. 8d. for 3½ years at 2½ %?
(7) What is the difference between the amount of £3,600 for 3½ years at 2½ % Compound Interest and the amount of the same sum for 3½ years at 2½ % Simple Interest?
(8) What sum at 5 % Compound Interest will amount in 2 years to £264 12s.?

NOTE: Results are to be calculated to the nearest penny.

Key to Exercise 41.

(1) 3 : 4. (2) 5 : 7. (3) 151 : 20. (4) 5 : 7. (5) 2 : 1. (6) 2d. (7) 6s. (8) 2s. (9) 3s. (10) 110 yds. (11) 7 : 5. (12) 100 : 120. (13) 13 : 10. (14) 3 : 4. (15) £70. (16) £100. (17) 8 : 9. (18) 7 : 4.

Key to Exercise 42.

(1) Monday fortnight at 6 h. 36 min. P.M. (2) 100 days. (3) 3 days. (4) 5s. 3d. (5) 6¾ acres.

M. A. L.

ALGEBRA.—XVII

103. Points in a plane.—Let XOX′, YOY′ in Fig. 1 (called the **axes of x and y**) be two straight lines fixed in a plane. Their positive direction is indicated by arrow heads. For convenience we shall take these axes at right angles to each other, but it is not necessary to do so, and in some cases another angle is often found to be more convenient.

The intersection O is called the **origin.**

The plane is divided into 4 spaces XOY, YOX′, X′OY′, and Y′OX; these are called the first, second, third and fourth **quadrants** (Fig. 1).

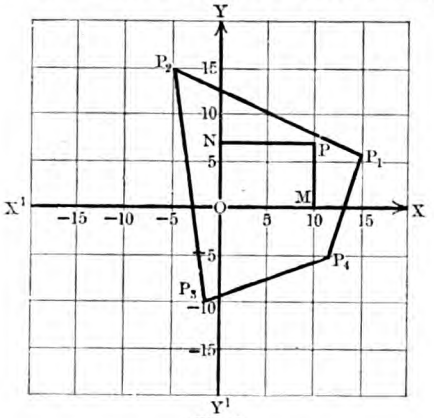


Fig. 1

Consider any point P in the plane and draw through P straight lines parallel to the axes, meeting X′OX in M and Y′OY in N.

M and N are called the **projections** of P on the axes of x and y.

Clearly when P is given, the positions of M and N are fixed; and when M and N are given, the position of P is fixed.

If we take O as the origin of co-ordinates, we have seen in an earlier lesson that we can define the positions of M and N by means of two algebraic quantities x and y, which indicate steps taken from O along X′OX and Y′OY, steps to the right corresponding to positive and steps to the left to negative values of x and y.

Since x and y define the positions of M and N, they also define the position of P.

x and y are called the **co-ordinates** of P, and P may be spoken of as the **point** (x,y); x is often called the **abscissa** and y is called the **ordinate** of P.

This system of defining a point is called the Cartesian system.

It is clear that the signs of the co-ordinates determine the quadrant in which P lies.

The co-ordinates of P_1 are $+15, +6$ and P_1 is therefore a point in the first quadrant; the co-ordinates of P_2 are $-5, +15$, and P_2 therefore lies in the second quadrant; the co-ordinates of P_3 are $-2, -10$, therefore P_3 lies in the third quadrant; and the co-ordinates of P_4 are $+12, -5$ and therefore P_4 lies in the fourth quadrant.

$P_1\ P_2\ P_3\ P_4$ is the figure whose angular points are $(15, 6)$, $(-5, 15)$, $(-2, -10)$, and $(12, -5)$.

As a rule the scale units of x and y are taken to be the same, but in some cases, as will be seen later, it is convenient to take the scale of y either greater or less than that of x. Marking a point in the above method is known as **plotting a point,** or if there are a succession of points, as **plotting a curve.**

The student should get some *squared paper* as represented in the figure, and plot points and curves for himself. Such paper is usually obtainable, but if it is not available, the student must use plain paper, and measure off the distances, etc., by means of a set square, dividing compasses and a ruler marked in tenths of inches, or in millimetres.

Exercise 24

Plot the following pairs of points and draw the line joining them :—

(1) $(3, -1)$ $(-4, 2)$. (2) $(-1, -3)$ $(5, 1)$. (3) $(0, 6)$, $(-5, 0)$. (4) $(2{\cdot}5, -3)$ $(1{\cdot}5, 4)$. (5) Plot the points $(1, 3)$, $(-3, -9)$, and show that they lie on a line passing through the origin.

104. The graph of a function.

Let $f(x)$ represent a function of x, and let its value be denoted by y. If we give to x a series of numerical values, we shall get a corresponding series for y. If these are set out as abscissae and ordinates respectively, we plot a succession of points. If all such points were plotted we should arrive at a line, either straight or curved. Such a line is called the **graph of the function** $f(x)$, or the **graph of the equation** $y = f(x)$.

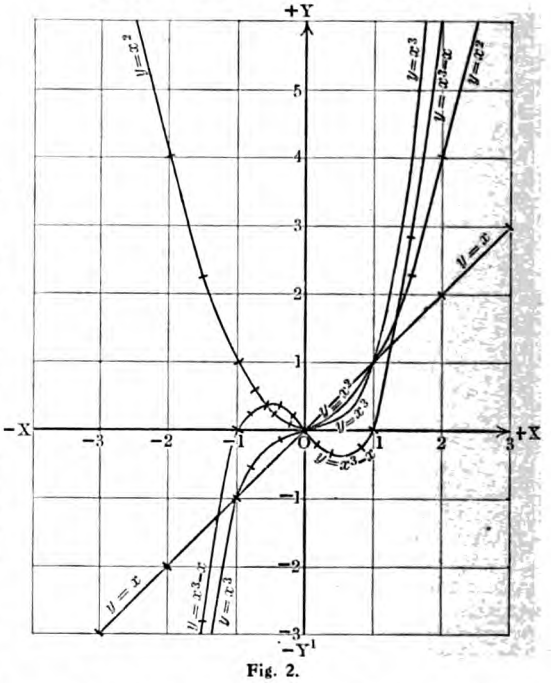


Fig. 2.

The variation of the ordinates shows the variation of the function.

In practice it is not possible to plot all the points, but a few points very accurately plotted enable one to draw the graph with sufficient exactness.

The student should note the following statements, and convince himself of their correctness.

(1) The co-ordinates of the origin are (0,0).

(2) The abscissa of every point on the axis of y is 0.

(3) The ordinate of every point on the axis of x is 0.

(4) The graph of all points having the same abscissa is a line parallel to the axis of y (e.g. $x = 3$).

(5) The graph of all points having the same ordinate is a line parallel to the axis of x (e.g. $y = -2$).

(6) The distance of any point from the origin is given by $OP^2 = x^2 + y^2$.

Examples:—

(1) Plot the graph of $y = x$.

x	-3	-2	-1	0	1	2	3
y	-3	-2	-1	0	1	2	3

This gives the corresponding values of y for the values -3, -2, -1, 0, 1, 2, 3 of x.

Since when $x = 0$, $y = 0$, the graph passes through the origin and is the straight line which will be found in Fig. 2.

In Fig. 2 we have also plotted the graphs of the following: $y = x^2$, $y = x^3$, $y = x^3 - x$.

The series of values plotted are:

$y = x^2$

x	-2	$-1{\cdot}5$	-1	$-{\cdot}75$	$-{\cdot}5$	$-{\cdot}25$	0	${\cdot}25$	${\cdot}5$	${\cdot}75$	1	1·5	2
y	4	2·25	1	·56	·25	·06	0	·06	·25	·56	1	2·25	4

$y = x^3$

x	$-1{\cdot}5$	-1	$-{\cdot}8$	$-{\cdot}6$	$-{\cdot}4$	$-{\cdot}2$	0	${\cdot}2$	${\cdot}4$	${\cdot}6$	${\cdot}8$	1	1·5
y	$-3{\cdot}4$	-1	$-{\cdot}51$	$-{\cdot}22$	$-{\cdot}06$	$-{\cdot}01$	0	${\cdot}01$	${\cdot}06$	${\cdot}22$	${\cdot}51$	1	3·4

$y = x^3 - x$

x	$-1{\cdot}5$	-1	$-{\cdot}8$	$-{\cdot}6$	$-{\cdot}4$	$-{\cdot}2$	0	${\cdot}2$	${\cdot}4$	${\cdot}6$	${\cdot}8$	1	1·5
y	$-2{\cdot}88$	0	$+{\cdot}29$	$+{\cdot}38$	$+{\cdot}34$	$+{\cdot}19$	0	$-{\cdot}19$	$-{\cdot}34$	$-{\cdot}38$	$-{\cdot}29$	0	$+2{\cdot}88$

As was noted before, $y = x$ is a straight line since in all four cases $y = 0$ when $x = 0$, all the graphs pass through the origin.

In the graph of $y = x^2$ we see that as x varies continuously from $-\infty$ through 0 to $+\infty$, y diminishes continuously from $+\infty$ to 0 and then increases continuously to $+\infty$. It has no negative values and each value of the function occurs twice.

In the graph of $y = x^3$, as x varies continuously from $-\infty$ through 0 to $+\infty$ y varies continuously from $-\infty$ through 0 to $+\infty$.

The graph of $y = x^3 - x$ has other peculiarities. It has a maximum value * ·385 and a minimum value $-$ ·385. Each value of y lying between $+$ ·385 and $-$ ·385 occurs three times over as x varies from $-\infty$ to $+\infty$. The function vanishes three times, i.e. is equal to 0, when $x = -1$, $x = 0$ and $x = +1$.

105. Every Simple Equation of the First Degree can be reduced to one of the forms $y = ax$ or $y = ax + b$, and represents a straight line.

* A maximum value is one which is greater than all those which immediately precede and follow it, and a minimum value is one which is less than all those which precede and follow it.

Hence an expression of the form of $ax + b$ is said to be a **linear function of** x, and an equation such as $y = ax + b$ is said to be a **linear equation.**

106. Application to Simultaneous Equations.

We have seen that an infinite number of pairs of values of x and y can be found, which will satisfy a single equation between x and y. This is equivalent to saying that we can find an infinite number of points on any given line. If, however, we have two simultaneous equations of the first degree, connecting x and y, only one pair of values will satisfy them. This is equivalent to saying that two straight lines can only have one point in common, i.e. one point of intersection.

Examples:—

(1) Solve graphically the equations:

$$3x + 7y = 27$$
$$5x + 2y = 16$$

If the student plots them carefully, he will find the equations represent the lines in Fig. 3 which intersect at the point $x = 2$, $y = 3$.

If he solves the equations in the ordinary way, he will be able to verify this solution.

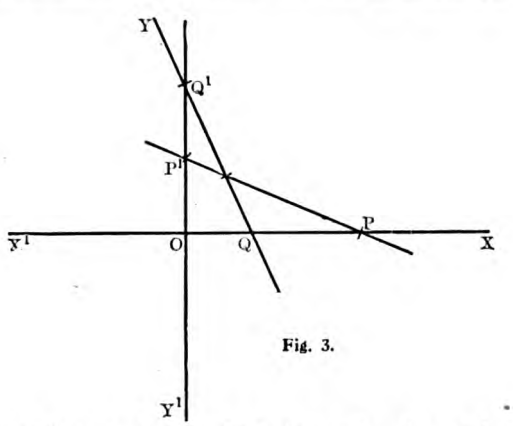


Fig. 3.

(2) Trace to a scale of $\frac{1}{2}$ inch = unity, the graphs of

(1) $y = 2(x - 3)^2$

(2) $y = \frac{2}{x} + \frac{1}{2}$

By means of the graph find as many values of x as you can which satisfy the equation

$$4x(x - 3)^2 = 4 + x$$

London Matric. Examination.

See Fig. 4.

$y = 2(x-3)^2$

x	1	1·5	2	2·5	3	3·5	4	4·5	5
y	8	4·5	2	·5	0	·5	2	4·5	8

$y = \frac{2}{x} + \frac{1}{2}$

x	1	1·5	2	2·5	3	3·5	4	4·5	5
y	2·5	1·83	1·5	1·3	1·17	1·07	1	·94	·9

For function (1) we get when $x = 0$, $y = 18$, which would make the graph enormous on the given scale.

Hence to see whether the curves cut at another point besides A and B on Fig. 4 we will plot them again on a different scale (see Fig. 5).

Here the scale of x is the same as before, but the scale of y is reduced to $\frac{1}{4}$ inch = unity.

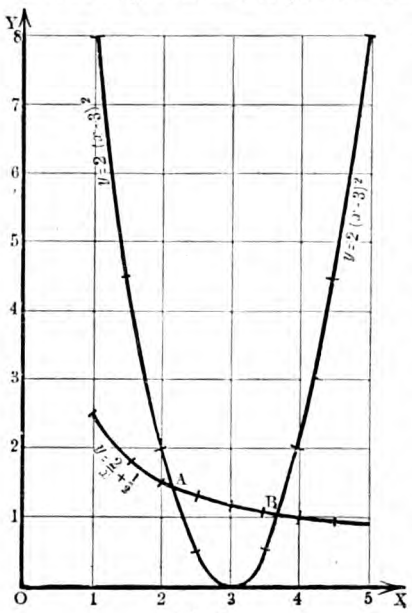


Fig. 4.

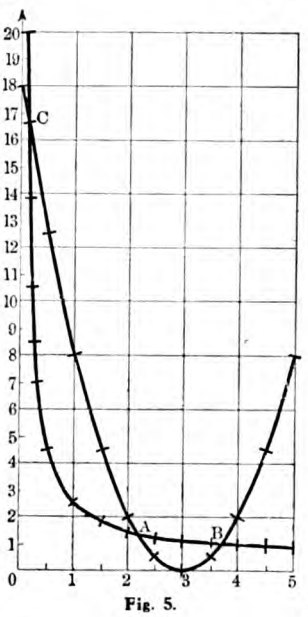


Fig. 5.

To calculate the additional values.

$y = 2(x-3)^2$ and $y = \frac{2}{x} + \frac{1}{2}$

x	·5	0
y	12·5	18

x	·5	·3	·2	·1	0
y	4·5	7·2	10·5	20·5	$+\infty$

Thus we see that the equation $4x(x-3)^2 = 4 + x$ is satisfied by the values $x = 3{\cdot}75$, $x = 2{\cdot}19$ and $x = {\cdot}1$.

107. We shall now plot a few typical graphs.

(1) $2y = x^2$ (Fig. 6).

This curve is called a **parabola.**

It is, in fact, of the same kind as $y = x^2$ plotted in Fig. 2, and has the same characteristics.

x	y
− 3	4·5
− 2	2
− 1	·5
0	0
1	·5
1·5	1·125
2	2
2·5	3·125
3	4·5

(2) Plot the graph of $x^2 + y^2 = 64$.

This may be written

$$y = \pm\sqrt{64 - x^2} \quad \text{(Fig. 7).}$$

In order that y may be real $64 - x^2$ must be >0.

$\therefore$ x can only lie between the values − 8 and + 8.

Again we may write it

$$x = \pm\sqrt{64 - y^2}$$

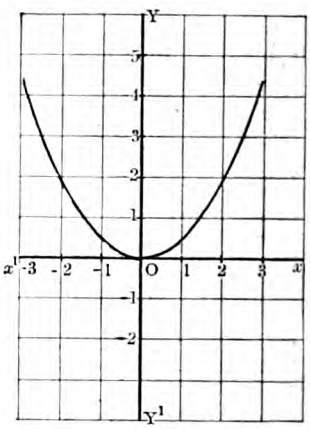


Fig. 6.

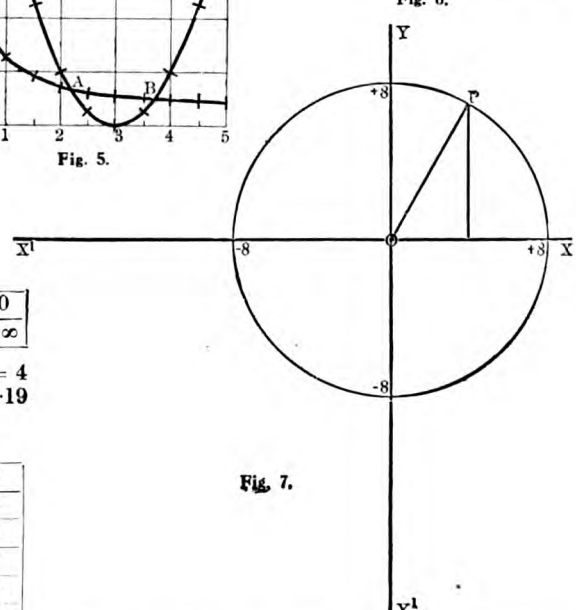


Fig. 7.

In order that x may be real y must lie between − 8 and + 8. The curve is clearly a circle.

(3) $xy = 4$.

(1) *Positive values*

x	y
0	∞
1	4
2	2
3	$1\cdot\dot{3}$
4	1
5	$\cdot 8$
6	$\cdot\dot{6}$
.	.
.	.
.	.
∞	0

Negative values

x	y
-0	$-\infty$
-1	-4
-2	-2
-3	$-\dot{3}$
-4	-1
-5	$-\cdot 8$
-6	$-\cdot\dot{6}$
.	.
.	.
.	.
$-\infty$	0

This curve is known as a **hyperbola.**

As we recede farther from the origin on the x axis, y becomes smaller and smaller, the curve approaching the x axis, which however it does not touch until $x = \pm \infty$. Similarly as we approach the origin on the x axis, y becomes greater and greater, the curve approaching more and more nearly to the y axis, but not touching it till $x = 0$.

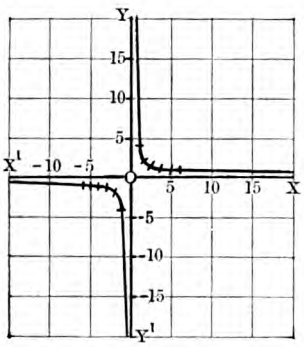


Fig. 8.

Notice that as x passes through 0 from a negative to a positive value, y changes from $-\infty$ to $+\infty$.

A straight line to which a curve approaches more and more nearly, without, however, touching it until it reaches infinity, is called an **asymptote.** In Fig. 8 the axes of x and y are asymptotes to the curve.

Exercise 25

Plot the graphs of the following:—

(1) $y = x + 3$. (2) $y = 5x - 4$. (3) $5x - 2y = 8$.

Solve the following equations graphically:—

(4) $y = 3x + 4$. $y = x + 8$ (5) $6y - 5x = 18$. $4x = 3y$ (6) $2x + y = 0$ $y = \frac{4}{3}(x + 5)$.

(7) With the same axes of x and y draw the graphs of (i) $y = 2x - \frac{1}{2}x^2$ (ii) $y = \frac{1}{2}x - 2$.

Write down the quadratic equation whose roots are the values of x at the points of intersection of the graphs.

(8) Draw on a large scale the graph of x^3 for values of x between ± 2, and then by drawing other graphs in the same figure solves the equations

(i) $x^3 = 2x + 1$

(ii) $x^3 = -4x + y$.

Key to Exercise 22

(1) 8 hours. (2) 5s. 6d. (3) 1·24 secs. (4) 23 hrs 16 min.; 5 hrs. 35 min.

Key to Exercise 23

(1) $m^3 + mn^2 + pn^2 = 0$. (2) $a^4 - 4ac^3 + 3b^4 = 0$. (3) $a + b + c + abc = 0$.

M. A. L.

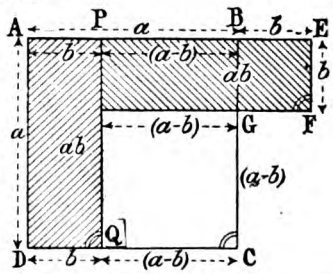
GEOMETRY.—XVI

Proposition 95. Theorem

If a straight line be divided into any two parts, the sum of the squares on the whole line and on one of the parts is equal to twice the rectangle contained by the whole line and that part together with the square on the other part.

Let the str. line A B of length a be divided at P into two parts b and $(a - b)$

It is required to prove that A B^2 + A P^2 = P B^2 + 2 rect. A B, A P.



Proof. — Fig. A C = square on A B = a^2

Fig. B F = square on B E = b^2

Thus we see Fig. A E F G C D = sum of square on the whole line A B and square on one part of the line A P.

Now Fig. A E F G C D is made up of Fig. A Q + Fig. P F + Fig. G Q.

Now Fig. A Q = rectangle A D, A P = rect. ab and Fig. P F = rectangle A B, A P for P E = P B + B E = $(a - b) + b = a$

and E F = b ∴ Fig. P F = rect. ab

Also Fig. G Q = square on P B = $(a - b^2)$

∴ Fig. A E F G C D = A B^2 + A P^2 = P B^2 + 2 rect. A B, A P.

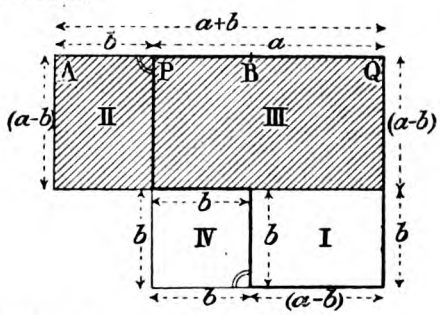
This illustrates the algebraic formula

$$\mathbf{a^2 + b^2 = (a - b)^2 + 2ab}$$

$$\mathbf{i.e.\ (a - b)^2 = a^2 - 2ab + b^2}$$

Proposition 96. Theorem

If a straight line be bisected and produced to any point, the rectangle contained by the whole line thus produced and the part produced is equal to the difference of the square on the line made up of the half and the part produced, and the square on half the line bisected.



Let the str. line A B be bisected at P and produced to Q, so that A P = P B = b.

A Q = $(b + a)$ and B Q = $(a - b)$

It is required to prove that rect. A Q, B Q = P Q^2 − A P^2.

Proof.—Figs. II and III make up the rectangle A Q, B Q = rect. $(a + b)(a - b)$

The heavily outlined Figs. made up of I and III make up the part which remains when square on P B = b^2 (Fig. IV) is taken away from the square on P Q = a^2 (Figs. I, III and IV)

Now Fig. I = rect. $b(a - b)$ = Fig. II

Hence rect. A Q, B Q = Figs. II and III = Figs. I and III = Figs. I, III and IV minus Fig. IV

i.e. rect. A Q, B Q = P Q^2 — A P^2

This illustrates the algebraic formula

$(a + b)(a - b) = a^2 - b^2$

Proposition 97. Theorem

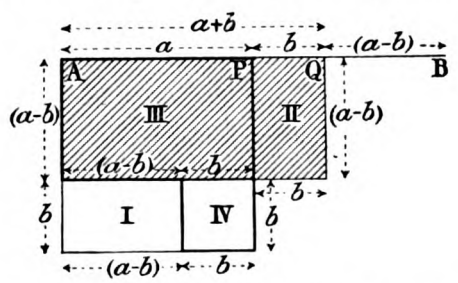
If a straight line be divided equally and unequally the rectangle contained by the unequal parts is equal to the difference of the square on half the line and the square on the line between the points of section.

Let the str. line A B be bisected at P and unequally divided at Q so that A Q = $a + b$, P Q = b, Q B = $a - b$.

It is required to prove that rect. A Q, Q B = A P^2 — P Q^2

Proof.—Figs. II and III make up the rect. A Q, Q B = rect. $(a + b)(a - b)$

The heavily outlined Fig. made up of Figs. III and IV makes up the part which remains when the



square on P Q = b^2 (Fig. IV) is taken away from the square on A P = a^2 (Figs. I, III and IV)

Now Fig. I = rect. $(a - b)\ b$ = Fig. II.

Hence rect. A Q, Q B = Figs. II and III = Figs. I and III = Figs. I, III and IV minus Fig. IV

i.e. the rect. A Q, Q B = A P^2 — P Q^2

This, as the preceding Proposition, illustrates the algebraic formula **$(a - b)(a + b) = a^2 - b^2$**

Proposition 98. Theorem

If a straight line be divided into two equal parts and also into two unequal parts, the sum of the squares on the unequal parts is equal to twice the sum of the squares on half the line and on the line between the points of section.

Let the str. line A B be divided equally at P and unequally at Q so that A P = a, P Q = b and Q B = $(a - b)$

It is required to prove that A Q^2 + Q B^2 = 2 (A P^2 + P Q^2)

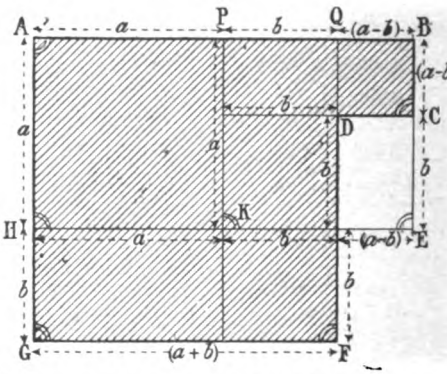
Proof.—The heavily outlined and shaded Fig. A B C D F G is made up of the Figs. A F = $(a + b)^2$ and Q C = $(a - b)^2$

Now A P = P B = a ∴ Fig. A K + Fig. P E = $a^2 + a^2 = 2a^2$

Fig. H F is made up of Fig. K F and Fig. G K = b^2 + rect. ab

Also Fig. C K is made up of Fig. K D + Fig. D E = b^2 + rect. $b(a - b)$

but Fig. C K = rect. ab = Fig. G K



Now A B C D F G is made up of Fig. A K + Fig. P E — Fig. D E + Fig. G K + Fig. K F

∴ A B C D F G = $2a^2 - b(a - b)$ + Fig. C K + b^2 = $2a^2 - b(a - b) + b^2 + b(a - b) + b^2$ = $2a^2 + 2b^2$

i.e. A Q^2 + Q B^2 = 2 (A P^2 + P Q^2)

This illustrates the algebraic formula

$(a + b)^2 + (a - b)^2 = 2a^2 + 2b^2$

Proposition 99. Theorem

If a straight line be bisected and produced to any point, the sum of the squares on the whole line thus produced and on the part produced is equal to twice the sum of the squares on half the line bisected and on the line made up of the half and the part produced.

Let the str. line A B be bisected at P and produced to Q so that A P = P B = b and B Q = a

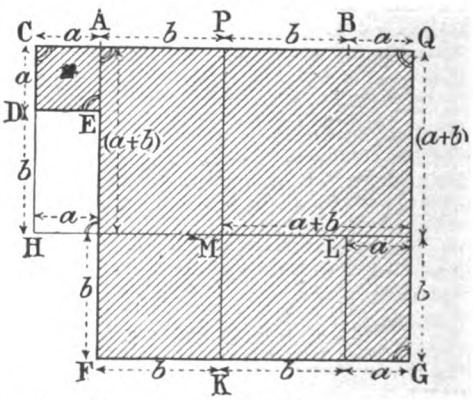
Then P Q = $a + b$ and A Q = $a + 2b$

It is required to prove that A Q^2 + B Q^2 = 2 (A P^2 + P $Q)^2$

Proof.—Let A C = B Q = a

The shaded Fig. C Q G F E D is the sum of the square on A Q = $(a + 2b)^2$ and the square on A C = a^2

Now Fig. C M = $(a + b)^2$ and Fig. Q M = $(a + b)^2$



Further Fig. F M = b^2 and Fig. K L = b^2

Fig. L G = rect. $a\ b$ = Fig. E H.

Now Fig. C Q G F E D is made up of

Fig. M Q + Fig. F M + Fig. K L + Fig. L G + Fig. A M + Fig. C E

i.e. of Fig. M Q + Fig. F M + Fig. K L + Fig. H E + Fig. A M + Fig. C E

but Fig. H E + Fig. A M + Fig. C E = Fig. C M

∴ Fig. C Q G F E D

= Fig. M Q + Fig. F M + Fig. K L + Fig. C M

$= (a + b)^2 + b^2 + b^2 + (a + b)^2$

$= 2\left\{b^2 + (a + b)^2\right\}$

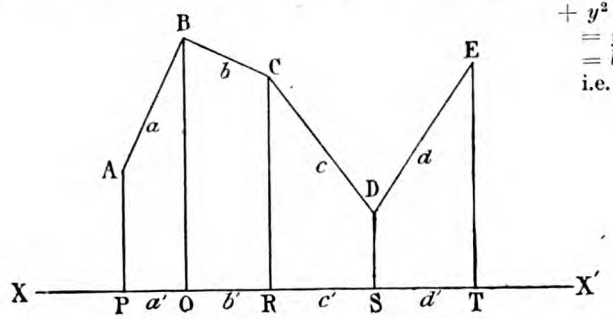
i.e. A Q^2 + B Q^2 = 2 (A P^2 + P Q^2)

This illustrates the algebraic formula

$$(a + 2b)^2 + a^2 = 2(b^2 + (a + b)^2$$

Definitions.—If perpendiculars be drawn from a series of points to a fixed straight line, the **foot of each perpendicular** is called the **projection** of the point from which it is drawn, on the fixed straight line.

The **portions of the fixed straight line intercepted by the perpendicular** from successive points are called the **projections** of the lines joining those points, on the fixed straight line.

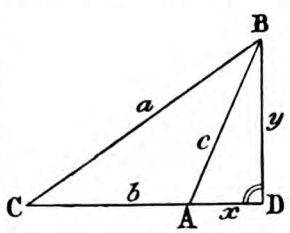


If X X′ be the fixed str. line, and A, B, C, D, E a number of pts.

Then P Q R S T are the projections of the pts. A, B, C, D, E on X X′ and a', b', c', d', are the projections of the lines a, b, c, d on X X′.

Proposition 100. Theorem

In an obtuse angled triangle, the square on the side subtending the obtuse angle is equal to the sum of the squares on the sides containing the obtuse angle, together with twice the rectangle contained by either of these two sides and the projection of the other upon it.



Let A B C be an obtuse angled triangle, having the obtuse ∠ at A.

Let B D be the ⊥ from B on C A produced.

Then A D is the projection of A B.

It is required to prove that B C^2 = A B^2 + A C^2 + 2 rect. A C, A D.

Proof.—B C = a, C A = b, A B = c, A D = x, B D = y

$a^2 = (b + x)^2 + y^2$ (Prop. 59)

$= b^2 + 2bx + x^2 + y^2$ (Prop. 94)

$= b^2 + 2bx + c^2$ ($\because x^2 + y^2 = c^2$) (Prop. 59)

i.e. B C^2 = A B^2 + A C^2 + 2 rect. A C, A D

Proposition 101. Theorem

In any triangle, the square on the side subtending an acute angle is equal to the sum of the squares on the other two sides, diminished by twice the rectangle contained by one of those two sides and the projection of the other upon it.

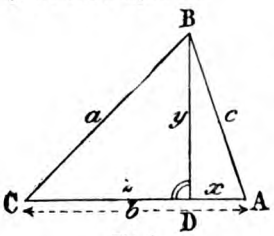


Fig. 1.

Let A B C be any △ with an acute ∠ at A. Let B D be the ⊥ from B on A C or A C produced.

It is required to prove that B C^2 = A B^2 + A C^2 − 2 rect. A C, A D

Proof.—B C = a, C A = b, A B = c, D A = x, D C = z, B D = y

$a^2 = y^2 + z^2 = y^2 + (b - x)^2$ (Fig. 1) or $= (x - b)^2 + y^2$ (Fig. 2) (Prop. 59)

$= y^2 + b^2 - 2bx + x^2$ (Prop. 95)

$= b^2 - 2bx + c^2$ (for $y^2 + x^2 = c^2$). (Prop. 59)

i.e. B C^2 = A B^2 + A C^2 − 2 rect. A C, A D

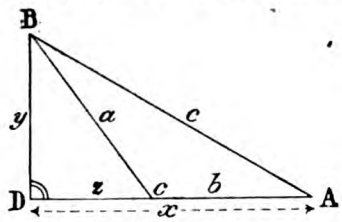


Fig. 2.

Definitions.—If two quantities of the same kind be compared with respect to magnitude, the number of times the first contains the second is lled the **ratio** of the first to the second.

The ratio of a to b is expressed either by the fraction $\frac{a}{b}$ or thus $a : b$.

Any four quantities are said to be in **proportion** if the ratio of the first to the second equals the ratio of the third to the fourth.

Thus a, b, c, d are **proportionals** if $\frac{a}{b} = \frac{c}{d}$ or, as we may write it $a : b = c : d$.

a and d are called the **extremes**

b and c are called the **means**.

The student should prove the following statements, which are also discussed in the courses on arithmetic and algebra.

(1) If $\frac{a}{b} = \frac{c}{d}$ then $\frac{b}{a} = \frac{d}{c}$

(2) If $\frac{a}{b} = \frac{c}{d}$ then $\frac{a}{c} = \frac{b}{d}$

(3) If $\frac{a}{b} = \frac{c}{d}$ then $\frac{a + b}{b} = \frac{c + d}{d}$

(4) If $\frac{a}{b} = \frac{c}{d}$ then $\frac{a - b}{b} = \frac{c - d}{d}$

(5) If $\frac{a}{b} = \frac{c}{d}$ then $\frac{a - b}{a + b} = \frac{c - d}{c + d}$

(6) If $\frac{a}{b} = \frac{c}{d}$ then $ad = bc$

Quantities are said to be in **continued proportion** or in geometric progression if

$\frac{a}{b} = \frac{b}{c} = \frac{c}{d} = \frac{d}{e} \ldots .$

The ratio $\frac{a^2}{b^2}$ is called the **duplicate ratio** of $\frac{a}{b}$

The ratio $\frac{a^3}{b^3}$ is called the **triplicate ratio** of $\frac{a}{b}$

If 3 quantities a, b, c be in continued proportion then $\frac{a}{b} = \frac{b}{c} \therefore b^2 = ac$

b is called the **geometric mean** of a and c.

Also c is called the **third proportional to** a and b.

If $\frac{a}{b} = \frac{c}{d}$, d is called the **fourth proportional** to a, b and c.

Before reading the following proportions, the student should re-read additional theorem C, on page 499, Vol. I.

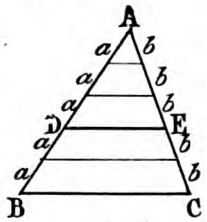


Fig. 1.

Proposition 102. Theorem

Any straight line drawn parallel to the side of a triangle, cut each of the other sides, produced if necessary, in the same ratio.

Let A B C be the △

Let D E be the line drawn ‖ to B C.

It is required to prove that $\frac{A D}{D B} = \frac{A E}{E C}$

Proof.—Divide A D into any number of equal parts and from D B cut off lengths each equal to one of these parts.

It is usually easy to choose the number of parts into which A D is divided so that D B contains the length of each part an integral number of times. Thus in Fig. 1 we have 3 parts each equal to a in A D and 2 parts each equal to a in D B, while in Fig. 2 we have 5 parts each $= c$ in A B and 8 parts each $= c$ in B D.

If after dividing A D and cutting off equal lengths from B D, a space is left over between the last point and B, we must increase the number of parts we take in A D, until the last point of the lengths cut off from D B coincides with B, or falls so close to it that the distance between it and B is negligible.

Through the points thus obtained in A B and B D draw lines ‖ to B C cutting A E and E C.

These lines will cut off equal lengths along A E and E C

(Additional Theorem C, Vol. I., page 499.)

Thus in Fig. (1) A D is divided into a number of equal lengths a and A E is divided into the same number of equal lengths b.

D B is divided into a number of equal lengths a and E C is divided into the same number of equal lengths b.

The same holds good for Fig. 2 if we substitute c and d for a and b.

Hence it is clear that A D bears the same ratio to D B as A E to E C

(In Fig. 1 $\frac{A D}{D B} = \frac{3a}{2a} = \frac{3}{2}$ and $\frac{A E}{E C} = \frac{3b}{2b} = \frac{3}{2}$

In Fig. 2 $\frac{A D}{D B} = \frac{3c}{8c} = \frac{3}{8}$ and $\frac{A E}{E C} = \frac{3d}{8d} = \frac{3}{8}$)

$\therefore \frac{A D}{D B} = \frac{A E}{E C}$

Proposition 103. Theorem. (Converse of Prop. 102)

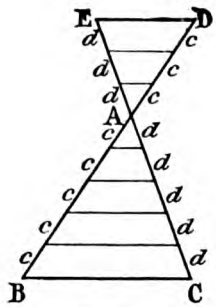


Fig. 2.

If a straight line cut two sides of a triangle in the same ratio, that straight line is parallel to the third side.

Let A B C be the △, and let the str. line D E cut A B, A C so that $\frac{A D}{D B} = \frac{A E}{E C}$ (Fig. 3).

It is required to prove that D E is ‖ to B C.

Proof.—If D E be not ‖ to B C, through D draw D F ‖ to B C.

Then $\frac{A F}{F C} = \frac{A D}{D B}$ (Prop. 102)

$\therefore \frac{A F}{F C} = \frac{A E}{E C}$

$\therefore \frac{A F}{A F + F C} = \frac{A E}{A E + E C} \quad \therefore \frac{A F}{A C} = \frac{A E}{A C}$

$\therefore A F = A E$

$\therefore$ pts. F and E coincide

i.e. D E is the str. line through D ‖ to B C.

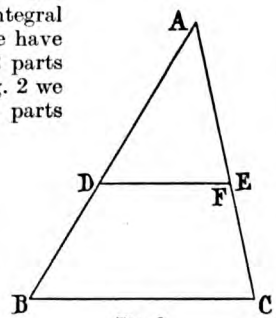


Fig. 3.

Exercise 19

(1) If P and Q are two points on the line A B, and if the rectangles A P, P B and A Q, Q B are equal, prove that A P = B Q.

(2) Divide a straight line three inches long into two parts, the difference of the squares upon these parts being one square inch.

(3) If a straight line be divided into three parts prove that the square on the whole line exceeds the sum of the squares on the three separate parts by twice the sum of the three rectangles contained by each pair of the parts.

(4) A B C is any triangle, D a point on the side B C. Show that if A C^2 is greater than A D^2 + D C^2, then A B^2 is less than A D^2 + D B^2.

Show also why if D is the middle point of B C, the excess in the one case is equal to the deficiency in the other.

(5) If A B C is a triangle with the angle B acute, show that A C^2 is less than A B^2 + B C^2.

Show how to draw accurately a rectangle whose area shall be the excess of A B^2 + B C^2 over A C^2.

(6) A B C is an equilateral triangle, D is a point in B C produced. Show that the square on A D is greater than the sum of the squares on B C, C D by the rectangle B C, C D.

M. A. L.

Continued from Vol. II., page 504.

BUSINESS AND COMMERCE

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—XVI

BILLS of lading are practically the same whether used for goods to be exported or for imports. They set out the name of the shipper, particulars of the goods, together with the marks on the packages, port to which the goods are consigned, and in some cases the rate of freight to be paid.

Three copies of the bill of lading for one consignment must be made out. One of them is retained by the master of the ship, one of them is sent by mail (preferably in advance) to the firm that is to receive the goods, and the third is kept by the shipper. The latter two copies must be stamped with a sixpenny revenue stamp. All the copies are sent to the shipping company, and when in due course the goods are delivered to the ship, they are examined by a clerk there, and if found to be in order he will notify his company, and two bills of lading will be returned, duly signed and completed. These bills, in fact, may be taken as being not only contracts to carry the goods, but also as receipts for the consignment. Moreover, the possession of the duplicate bill of lading at the port of discharge entitles the consignee to receive the goods from the ship when she arrives there.

Consular Invoices

It should be explained, however, that in the case of goods sent to a ship by barge the routine varies very slightly. When goods arrive by rail or road they are checked by a clerk to ascertain that they are in order; when they arrive by barge they are received by the mate of the ship, who gives a "Mate's Receipt," which in its turn is to be exchanged for the bill of lading.

We may assume, then, that the goods have been delivered to the ship and that the bills of lading have been released by the shipping company. The next step is to post a copy of the bill of lading to the consignee, and in the majority of cases it will arrive some days before the delivery of the goods, and give him an opportunity of arranging for their reception. With this document should also be sent an invoice or account for the goods, and this bill must be so complete that it shows precisely how the goods are packed, the marks upon the packages, number of packages, and the price of the goods. And, in addition, there must be shown the charges for carriage, insurance, and so on.

In the case of a few foreign ports, Consular Invoices must be sent as well; but the rule in this matter varies considerably from time to time, and, in any case, the blank forms supplied for the purpose to shippers fully explain their purpose and how they are to be used.

Through a Broker

So far as the insurance is concerned, this part of the routine of shipping receives attention directly it is definitely known by which vessel the goods are to be dispatched. So soon as this information is obtained, with certainty, the shipper sends to his insurance broker full details of the goods to be shipped, including their value and particulars of the ship, ports of departure and arrival, and the general nature of the risks against which it is desired to insure.

In due course the broker prepares what is known as a "Covering Slip," which contains over the broker's signature a recapitulation of the information supplied and a blank space in which is to be inserted by the underwriter or insurance company the particular rates of insurance to be charged. From this preliminary paper another is prepared, called a "Cover Note," and dispatched to the shipper, and when all is in order the actual policy is drawn.

All these charges—insurance, dock dues, railway carriage, and so on—may be paid by the consignor or consignee, according to

the terms upon which the goods are purchased; but in every case and with each document it must be made perfectly plain by whom the charges are being paid.

So much for the export of goods manufactured in this country, goods that are not concerned with the Custom House, except that a return of their dispatch must be made to the authorities almost as soon as the ship sails. We come now to goods produced abroad and imported for the sole purpose of being re-exported.

To make our point the clearer, we may imagine that a merchant shipper has received from abroad an order for a dozen cases of champagne. Immediately on receipt of the order he has written to his agents in France to buy and dispatch to him the wine, and it comes in due course from a French port, preceded by a bill of lading from the shipper's French agents.

Now the point is that the shipper does not wish to pay duty for landing the wine in this country, so he must arrange to transfer the cases to the ship that is to take them to their ultimate destination. His routine, then, is somewhat as follows: First, he fills up the required forms and documents, and has them passed by the Custom House authorities. Then he goes to the brokers of the French ship, pays the freight, if necessary, and presents the bill of lading, which, if everything is correct, is returned to him with an order authorising the delivery of the wine.

Transhipment Bond Warrant

The next document that enters into the case is the Transhipment Bond Warrant, which is issued by the Customs authorities, and this is followed by a Transhipment Shipping Bill and Delivery Order. In most cases the goods will be taken from one ship to the other by means of a lighter or barge, and the lighterman, armed with the bill of lading and other authorised documents, collects the wine, delivers it to the outbound ship, and receives in exchange a "Mate's Receipt." The new bills of lading, invoices and insurance forms are then prepared.

Then there are goods obtained from abroad and warehoused in bond. Tea would come under this heading, and so would coffee or tobacco. The goods have to be obtained from the bonded warehouse without the payment of duty, got on board the outgoing ship and sent away, but it is obvious that steps must be taken to protect the British revenue.

With this end in view the Customs authorities demand a bond from the shipper that the goods are indeed to be either shipped or, in the event of failure to ship, be returned to the bonded warehouse from which they were taken. Under this bond some person of position and standing must act as surety, and the bond itself bears a stamp varying in amount according to the value of the goods in question.

The next step is to obtain an "Export Warrant" from the authorities, and attached to this document is an order authorising the warehouseman to deliver up the goods. A further document is called the "Shipping Bill," and it affords full details as to the goods, the vessel by which they are to be dispatched, and similar information.

But eventually, having fulfilled all these formalities, which are naturally of the utmost importance to the revenue of the country, the shipper hands to the lighterman or carman who is to obtain the goods from the warehouse the necessary documents, and to him are actually delivered the goods for removal to the ship.

Free Entries

Then follows much the same procedure as was the case with the home-manufactured goods. If the consignment is taken to the ship by water a Mate's Receipt is obtained that the articles have been received in good condition or otherwise as the case may be. If it is taken by road the bill of lading is handed over, but with the handling of goods from a bonded warehouse there is an officer of Customs in waiting who also demands an official receipt that the goods have been actually received into the hands of the shipping company's representative on board the ship.

There is yet another form of routine that is employed in certain cases. That is to say, it it possible to execute a bill of lading from the port of the actual dispatch of the goods right down to their destination, a sort of "through ticket" that would embrace the port of transhipment. To explain the matter a little more clearly, a case of champagne may be ordered from South American merchants. It is to be bought in France, to come to a British port by one steamer, there to be transhipped to another vessel for transit to its ultimate destination. If the plan we are discussing were followed the bill of lading would be made out by the French shippers from the French port right through to the port in South America via England, and in this case the wine could be passed as a Free Entry.

A. B.

CHOOSING A CAREER.—XVII

The Post Office.—ONE of the biggest sections of the Government employ is that controlled by the POST OFFICE. This includes innumerable grades of all descriptions; with wages beginning at a few shillings, and annual salaries running to a thousand pounds and upwards. And one must remember that the Post Office embraces not only the handling of letters and newspapers; but also. parcels post, the telegraph and telephone services, Savings Bank, etc.

Though in the Post Office there are many openings for Class 1 Civil Service Clerks and those of the Abstractor Class (selected from the former Boy Clerk group), there are also grades that are exclusive to the Postal Department.

Thus, a candidate at the examinations of the Civil Service Commission for a Class 1 Clerkship may, if successful, find himself drafted to the Post Office. Class 1 Clerks, it will be remembered from a former lesson, are invariably young men of 22 years and over who have received public school and university education.

But, to go to the other extreme, the Post Office opens up a life-long career to boys of elementary education; with the prospect of a pension at the end of their service.

Boy Messengers form the lowest rung in the ladder of male postal employment. From this class are recruited many of the other classes, such as Assistant Postmen, Postmen, Telegraph Learners, Sorting Clerks, Telegraphists and Junior Clerical Assistants. So far as Postmanships are concerned, a proportion of the vacancies is reserved for Boy Messengers; the other portion being allocated to ex-Soldiers, ex-Naval men and ex-Airmen.

Boys may also be drafted to employment in the Engineering Department of the Post Office; and in certain circumstances may receive educational facilities to admit them as Sub-Office Assistants. Again, some of the vacancies in the Wireless Telegraphy branch of the Royal Navy are reserved for Boy Messengers.

In addition to all these eventual openings for the boys a guarantee is given by the Government that every boy who gives entire satisfaction, and can satisfy the Civil Service Commissioners as to his character and his physical and educational fitness, shall be retained permanently in the service of the Post Office. Thus in the service there is nothing of the "blind alley" position so often associated with boy labour.

It goes without saying in the first place that there are rigid Nationality regulations for candidates desirous of serving the Post Office. Each applicant for appointment must be a natural-born British subject and child of a father who is also a natural-born British subject. At the same time, exception to the latter condition may be made in the case of those who served in His Majesty's armed forces during the Great War.

So far as London is concerned, candidates for Boy Messengerships must be exempt from further attendance at school. Preference is given to those who have passed Standard VII, and boys must be in good health and able to pass certain tests in weight and chest measurement; whilst they should be at least 4ft. 8ins. in height.

The hours of duty are 50 weekly, apart from Sunday duty, for which extra payment is made. The work consists chiefly in the delivery of telegrams, but a certain number of boys are employed in dealing with messages within Post Office buildings.

Each year messengers are given a holiday of 12 week-days with full pay. During any illness free medical attendance is provided and two-thirds of the pay up to three months in a year until the boys are old enough to benefit under the provisions of the National Health Insurance.

Two pairs of boots are given each year; also a suit of summer clothing and one for winter wear, in addition to an overcoat, a waterproof cape and leggings.

Recreation clubs, gymnasia and physical training are provided for the boys, and educational classes are formed which Boy Messengers are required to attend for four hours a week during the first two years of their employment. Application for employment as an Outdoor Boy Messenger may be made at any of the chief Post Offices in the Metropolis.

Much the same prospects are held out to boys who join the Postal Service in the Provinces and particulars are obtainable at any Post Office. Generally speaking, the rate of wages is slightly less in the country than in London; but the pay compares most favourably with that at present offered in any other calling for boys.

Each half-year examinations are conducted among the boys reaching a certain age in that half-year; and upon the result of these tests messengers are selected for permanent retention in one or other branch of the Post Office service.

IN THE G.P.O., LONDON.

Three and a quarter thousand million letters, a thousand million postcards, one and a quarter thousand million
indication of the number of communications delivered annually in the United Kingdom, and will help to
Office does not confine itself to inland mails; it deals also with foreign mails, with telegrams, with telephone
and similar complexities. The Post Office, in fact, is a huge field for the

JRING A BUSY PERIOD.

wspaper packets, etc., one hundred and thirty million parcels—these figures may be taken as a rough ow how perfect is the organisation and how intricate the machinery of the Post Office. And the Post lls, with postal and money orders. Further, it has a Savings Bank and handles innumerable pension payments ıployment of men (and women) of all classes, types and temperaments.

Among openings for Boy Messengers is that offered by the Engineering Department. Only boys who are strong and healthy and who have a leaning towards things mechanical are selected. When a candidate has been selected he attends classes of about two hours' duration on two evenings a week in his own time. The period of training varies from six months to about two years and is very thorough.

After receiving the necessary training suitable boys are transferred to the Engineering Department as vacancies occur. They are then employed on telegraph and telephone construction, and maintenance work. Boys and youths of not less than 16 years have an opportunity of qualifying for well-paid posts, their own merit having much to do with their future rates of pay. Further, they have within their grasp the opportunity of qualifying for permanent employment and for rising to be first skilled workmen and then inspectors or chief inspectors.

In the Stores Department there are also openings for ex-Boy Messengers, either as Junior Mechanics or Junior Porters. Boy Messengers do not qualify in any way for pensions or gratuities unless by their merits they rise to a post in some of the permanent departments ; but, as a jumping-off ground in Postal employ, there are many chances—probably more than in other walks of life—for boys who have not by education qualified for something in the higher grades of the service.

As a matter of fact, the majority of the boys become Assistant Postmen and eventually Postmen. Indeed, to become a **Postman,** or rather an Assistant-Postman or part-time man, for this is the actual start that must be made, one must have been either a Boy Messenger, or a Naval man, Soldier or Airman. Postmen are now recruited only from these classes, and the primary selection of candidates from the forces rests with the Naval, Military and Air Authorities.

Beginning as Assistants, Postmen work their way up to become established servants of the Crown, qualified for all the advantages of superannuation or pension. The rates of wages paid to Assistant Postmen and to Postmen vary considerably according to locality, length of service, hours of duty and other more or less local details ; but inquiries regarding such matters would be answered by the Postmaster of any town if addressed to him in writing.

The task of a postman is arduous enough. He has to be out of doors in all weathers. Alike in sun and rain, and snow and frost he walks many miles every day, and it is particularly hard for him in the residential parts of towns where a flight of steps forms the front entrance of almost every house. Still, on the whole the life is healthy and invigorating.

Parcels Postmen are recruited in much the same way as Assistant and Established Postmen and differ from them only with regard to duties. In certain country districts where postmen still drive mail-carts an allowance is made for horse-keeping ; but **Mail Drivers,** whether of mechanical or horsed vehicles, are invariably engaged and paid by the various cartage contractors ; working at their ordinary trade union rates of pay. This applies to the men who drive the Motor Mails between large centres and also to those who have charge of the Mails by Air.

Male Sorting Clerks and **Telegraphists** are recruited entirely from Boy Messengers, Assistant Postmen, Postmen, Bagmen and a few other similar grades. When an examination is announced the candidate must make application for nomination through his superior, in accordance with regulations. He will be required to pass an examination in English composition, arithmetic (first four rules, simple and compound, including English and Metrical weights and measures, reduction, vulgar ractions and decimals, excluding recurring decimals), and geography. Much importance is attached to the handwriting of the candidate in this examination, for which a fee of five shillings has to be paid to the Civil Service Commissioners. Emphasis is placed, it need hardly be said, on neatness and accuracy: candidates would do well to make thorough preparation.

Travelling Sorting Clerks, i.e. those who work on mail steamers and trains, are also recruited from this class.

Still, in considering postal employment from the point of view of the youth of elementary education, the fact remains that the grade known as Boy Messengers constitutes the chief jumping-off ground and may well lead to life-long occupation.

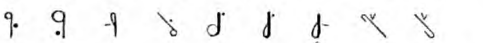
In all places where the necessary arrangements can be made with the local educational authorities there are special classes for Boy Messengers, where handwriting, spelling, composition, arithmetic, geography and history are taught ; and, every half-year, there are held for boys reaching 16 years of age in that half-year examinations to decide which candidates shall be selected for permanent retention in one or other branches of the Post Office service. A. C. M.

SHORTHAND.—X

Key to Exercise 37

1. soap, pass, sweep, pieces, step, pest, paced, pester, apple, puff.
2. supper, sweeper, stopper, pains, pounces, pounced, punster, pray, pain.
3. safe, face, swan, noses, stuff, fast, faster, offer, fun, aflow.
4. Friday, frill, flood, flog, suffer, fans, civil, supply, paves, contrives.
5. *The* clerk *has balanced the* ledgers *and* brought *down the balances.*
6. *We-shall-be*-pleased *to*-receive-*the balance at an* early date.
7. *The circumstances are* against *the* success *of-the* cycle show.
8. *A circumstance of no* value *was* allowed *to influence the* manager.

Key to Exercise 38

1.
2. 
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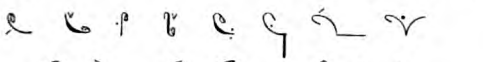
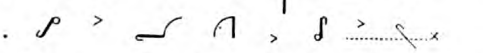
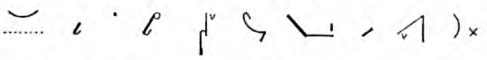
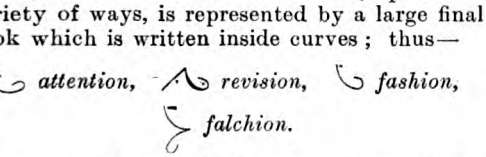
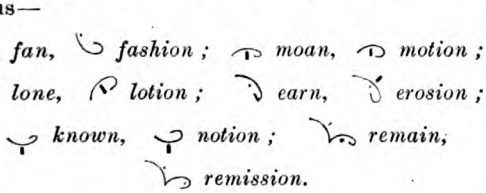
4. 
5. 
6. 

Shun Hook.—The words *attention, revision, fashion, falchion,* end in the syllables *-tion, -sion, -shion, -chion.* This sound of *shun*, spelt in a variety of ways, is represented by a large final hook which is written inside curves; thus—

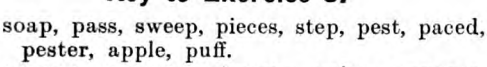

attention, revision, fashion, falchion.

A very useful exercise is to compare examples ending in the hook *n* and the *shun* hook; thus—

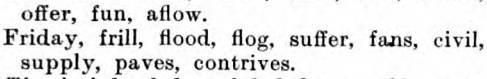

fan, fashion; moan, motion; lone, lotion; earn, erosion; known, notion; remain, remission.

In Pitman's Shorthand there is only one large final hook, and, therefore, when added to straight strokes the *shun* hook can be written either the one side or the other. From this it follows that the more convenient side will be chosen, and this varies according to the kind of straight stroke to which the hook is attached. One or both of two considerations decide the side on which to write the hook: (*a*) Easiness of outline; (*b*) Vowel indication.

When a straight stroke has an initial attachment (a circle, a loop, a hook), the *shun* hook is written on the side opposite to the initial attachment; thus—

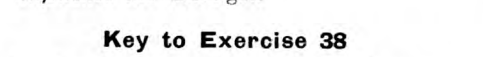

Prussian, oppression, conception, constipation, secretion, dissuasion.

After *fk*, *vg*, *lk*, the *shun* hook is written away from the curve; thus—


faction, fiction, affection, navigation, selection, legation.

In both these cases easiness of outline is the factor which decides the side on which the hook is to be written.

If there is no initial attachment to the straight stroke, then the *shun* hook is written opposite to the last vowel; thus—


action, option, caution, potion, occasion, embrocation, allocation, allegation, eruption, abrogation.

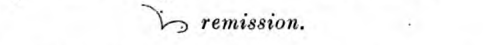
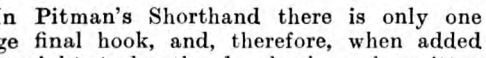
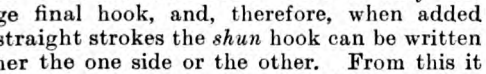
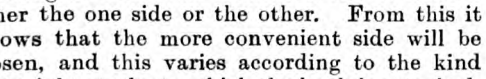
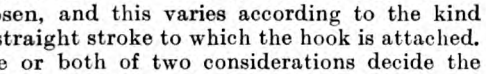
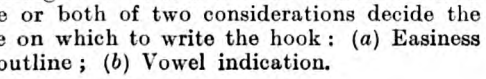
This is a case of vowel indication, the hook being written away from the last vowel. If vowel indication were carried out after simple *t, d, j,* very awkward outlines would result, in which the hook would be written in a backward direction. Between *t-shun, d-shun,* and *j-shun* there is always a vowel, and so in these cases there is no need to indicate a vowel. Under these circumstances a forward direction is chosen, and after simple *t, d,* and *j,* the *shun* hook is written on the right-hand side; thus—

imitation, erudition, magician, petition, perdition, logician.

Exercise 39

GRAMMALOGUES

subjection; subjective; generation; signification; information.

1.
2.
3. 
4. 
5. 
6. 
7. 
8. 

Key to Exercise 39

1. vision, session, motion, nation, elation, solution, oration, violation.
2. caution, cushion, Russian, passion, Goschen, option, attraction, education.
3. infection, navigation, location, suffocation, vacation, electrician, transaction.
4. exception, discussion, station, impression, inclusion, insertion, depression, depletion.
5. petition, exportation, invitation, gradation, adaptation, logician, magician, irritation.
6. *The* professor gave *us much information on-the* education *of-this generation.*
7. *Our subjection to-the belief* spoken *of in-the journal is of* considerable *signification at this*-time.
8. Joy, grief, hope *and*-fear *are* purely *subjective* states.

When *shun* follows the circle *s* or the circle *ns*, it is expressed by a hook written on the side opposite to the circle; thus—

ps-shun, pns-shun.

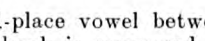
A third-place vowel between the circle and the *shun* hook is expressed by the vowel-sign being written outside the hook; thus—

decision, transition.

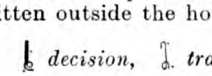
When the hook is left unvocalised, a second-place vowel is to be read between the circle and *shun*; thus—

compensation, condensation, procession, recession.

Circle *s* may be added to the *shun* hook, both large and small; thus—


additions, processions;

and both hooks may be used medially; thus—


occasional, processional, additional, petitioner.

Note that the upward or downward forms of *l* and *r* are written after *shun*, whichever gives the better joining.

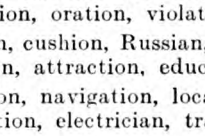
When a diphthong and a vowel occur immediately before *shun*, the stroke *sh* and the hook *n* must be written; thus—

situation, extenuation.

This gives the following distinctions—

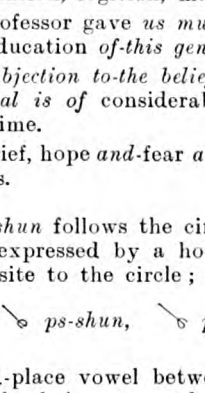
station, situation; extension, extenuation.

Note, however, that the following are written with the large hook because it is not necessary to provide for pairs of words—


punctuation, perpetuation, fluctuation, superannuation.

The large hook is a contraction for the syllable *-uation.*

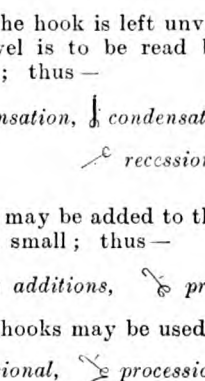
The following examples on the various hooks should receive the careful attention of the student:—


explain, explosion;
complain, completion;
prone, Prussian;
reprove, repression;
train, attrition;
crave, accretion;
recline, reclusion;
conclave, conclusion;
moan, motion;
earn, erosion.

Exercise 40

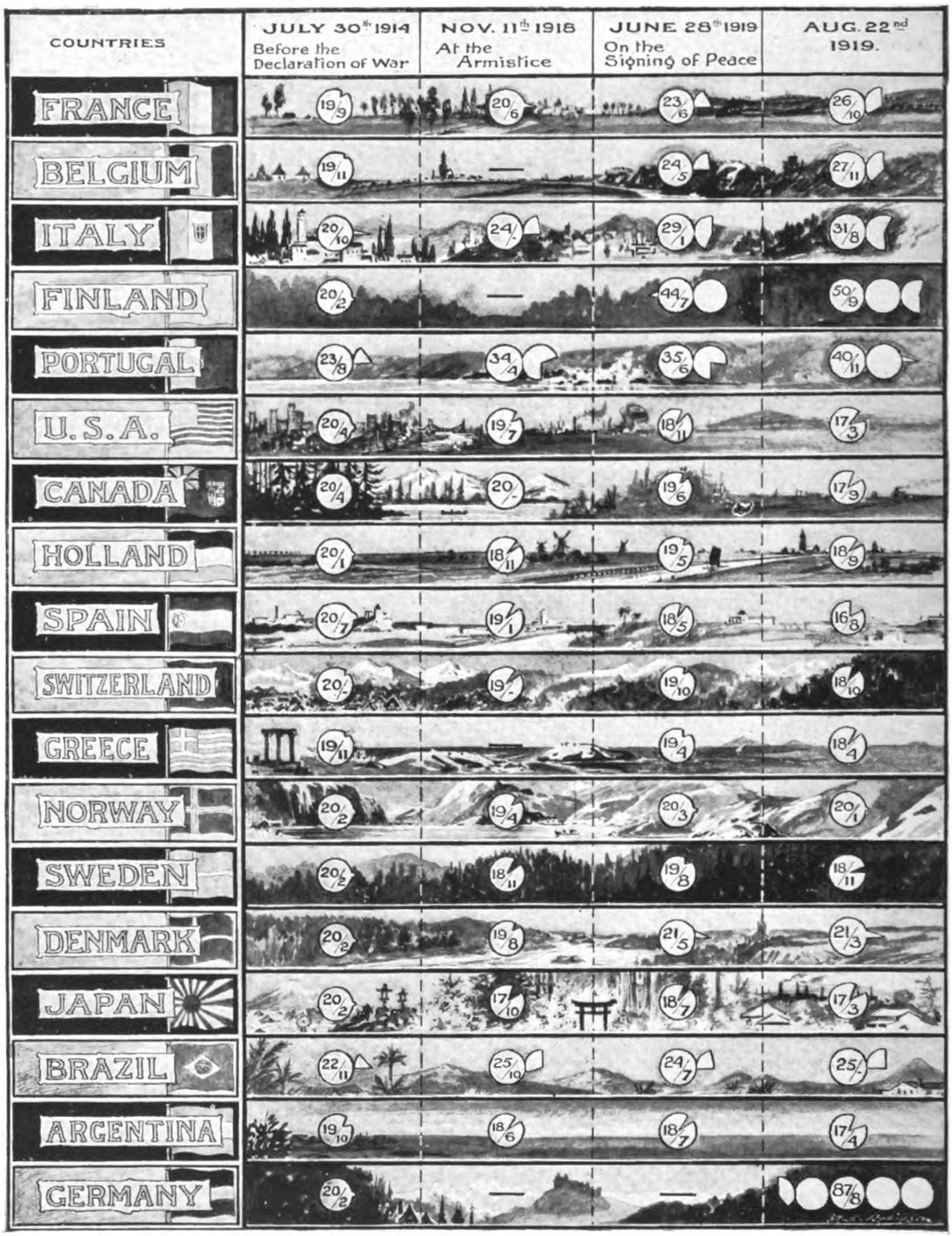
GRAMMALOGUES

satisfaction; justification; generalization.


1.
2.
3.
4.
5.
6.
7.
8.

Exercise 41

1. moan, motion, lane, elation, fan, fashion.
2. cough, caution, skin, section, conclusion, completion.
3. physician, physicians, motions, visions, situation.
4. diction, dictionary, mission, missionary, sensational.
5. *The information he* brought *to-the* station gave *much satisfaction.*
6. *He* showed some *justification for-his generalizations on-this generation.*
7. *We-shall next* discuss-*the subjective* states *of*-man.
8. *His subjection to-the* vice *is* full *of signification to*-lovers *of*-progress.



HOW A GREAT UPHEAVAL AFFECTED THE SOVEREIGN.

An interesting chart showing how the exchange value of the English sovereign fluctuated in various countries of the world during the period of the Great War.

Continued from Vol. II., page 449.

ENGLISH LANGUAGE AND LITERATURE:

Contributors:—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

SEVENTEENTH CENTURY MEN OF LETTERS

WE must now turn back and pick up some threads neglected while we have been tracing the Restoration drama and the career of Dryden.

In poetry, apart from the drama, mention must be made of Abraham Cowley, Edmund Waller, and Sir John Denham; in satire, Andrew Marvell and Samuel Butler; in prose, the essayists Cowley, Temple, and Halifax; the diarists Evelyn and Pepys; Dorothy Osborne as a letter-writer; Roger North as a memoir-writer; Edward Hyde, Earl of Clarendon, as a historian; and John Locke as a philosopher.

Cowley, who was born in 1618 and died in 1667, was the popular poet in Milton's day. In style he followed the elaborate "conceits" of Donne, and so condemned himself to oblivion; but his prose essays, easy, simple, and graceful, are still read, and they served as a natural introduction to the more sinewy prose of Dryden. A faithful loyalist, Cowley was disappointed in not securing adequate recognition at the Restoration, and lived his later life in dignified and honoured retirement.

Edmund Waller

To Edmund Waller, Dryden attributed the revival of the heroic couplet—ten-syllabled lines, each pair of lines rhyming, and containing a complete thought—a measure improved by Dryden, and perfected and done to death, as we shall see, by Pope. Weak and cowardly, Waller was an incorrigible Mr.-Facing-both-ways in public life. As a writer he was long regarded as "the glass of fashion and the mould of form." His versification was smooth, and he was one of the first of the minor poets to shun the far-fetched similes which encumber so much of the early seventeenth century poetry. Now he is only remembered by what other poets said of him, by one pretty song—"Go, Lovely Rose!"—and by some lines on light at life's eventide which may serve to illustrate his favourite metre:—

The soul's dark cottage, battered and decayed,
Lets in new light through chinks that time has made.
Stronger by weakness wiser men become,
As they draw near to their eternal home.
Leaving the old, both worlds at once they view,
That stand upon the threshold of the new.

Andrew Marvell

Sir John Denham, a faithful royalist who reaped a substantial reward, followed in the steps of Waller, and wrote with smoothness and polish. *Cooper's Hill*, a description of the scenery of the Thames Valley, is the only poem by which he is now remembered. His aspiration to write as the Thames flows—

O could I flow like thee, and make thy stream
My great example as it is my theme!
Though deep, yet clear; though gentle, yet not dull;
Strong, without rage; without o'erflowing, full.

was not fulfilled, for he is gentle without strength.

Andrew Marvell (1621–1678) was one of the balanced and sterling men of a corrupt period. He never bowed the knee to the Baal of concupiscence, whom so many of the poets rushed to worship when Charles II. returned to reign, but he served his Hull constituents in Parliament without fear and unseduced by favour, and ceased not to satirise, in vigorous prose, the foulness and folly of the times. Satire, the scourging of human paltriness and vice, is usually evanescent, and Marvell's satire is not now read, but he, on the Puritan side, and Butler, on the side of the Court, first worked

the vein of satire which was developed later by Dryden, and later still by Swift and Pope.

As a poet Marvell showed feelings we are apt to regard as modern—true love of the gentler side of Nature, and solicitous tenderness towards animal life. He wrote, too, the only truly poetic and sympathetically adequate descriptions of the deaths of both Cromwell and Charles I.

This of Charles :—

He nothing common did or mean
Upon that memorable scene,
But with his keener eye
The axe's edge did try ;
Nor called the gods with vulgar spite
To vindicate his helpless right,
But bowed his comely head
Down, as upon a bed.

And this of Cromwell :—

I saw him dead ; a leaden slumber lies,
And mortal sleep, over those wakeful eyes ;
Those gentle rays under the lids were fled,
Which through his looks that piercing sweetness shed ;
That port, which so majestic was and strong,
Loose, and deprived of vigour stretched along ;
All withered, all discoloured, pale and wan,
How much another thing, no more than man !
O human glory vain ! O death ! O wings !
O worthless world ! O transitory things !
Yet dwell that greatness in his shape decayed,
That still, though dead, greater than death, he laid,
And in his altered face you something feign
That threatens Death he yet will live again !

From the portrait by Sir Peter Lely.

SIR WILLIAM TEMPLE (1628–1699).

The most able English diplomatist of his time, as a man of letters earned the praise of Dr. Johnson, who described his style as "giving cadence to English prose."

Samuel Butler, who was born in 1612, published his satirical *Hudibras* in three parts between 1663 and 1678, and died in 1680, had a most unsatisfactory life. Though his poem attacking the Puritans was the delight of the Court, and of Charles himself, Butler received no reward, but lived for the most part in misery and died in poverty. The scheme of *Hudibras* is preposterously lumbering, the tone is uniformly bitter, and the jigging rhythm and tortured rhymes grow wearisome ; but the poem, which few can now read, is kept in memory by phrases and couplets that hit off some religious or other foible with an uncanny mixture of truth and malice. Perhaps the best-sustained sketch is that of a Puritan type :—

Such as do build their faith upon
The holy text of pike and gun ;
Decide all controversy by
Infallible artillery.
And prove their doctrines orthodox
By apostolic blows and knocks ;
Call fire, and sword, and desolation,
A godly thorough reformation,
Which always must be carried on,
And still be doing, never done ;
As if religion were intended
For nothing else but to be mended ;
A sect whose chief devotion lies
In odd perverse antipathies ;
In falling out with that or this,
And finding somewhat still amiss ;
That with more care keep holiday
The wrong than others the right way ;
Compound for sins they are inclined to
By damning those they have no mind to.
Still so perverse and opposite,
As if they worshipped God for spite.

Sir William Temple (1628–1699) was the most able English diplomatist of his time. His work was chiefly done in Holland, where he was popular and trusted. In his own country he felt himself unfitted for the game of party intrigue, and lived in studious retirement, from which neither the Stuart kings nor William III. could entice him. Temple wrote with a feeling for style which Dr. Johnson described aptly as "giving cadence to English prose." In discussing Ancient and Modern Learning he quickly got out of his depth, for he was only a general scholar ; but his essays on such topics as gardening, and still more his Memoir and Letters, are charming. Jonathan

Swift was for some time secretary to Temple at his country house, and published his Letters posthumously.

Temple married a royalist lady, Dorothy Osborne, after seven years' courtship, and her letters to him, which were not published till 1888, are among the brightest examples of correspondence in English literature. They describe the everyday life of an English girl in the middle of the 17th century with delightful shrewdness and vivacity. Dorothy died five years before her husband, whom she had helped appreciably in his diplomacy.

George Savile, Marquess of Halifax (1633–1695), equally well balanced as a statesman and a writer, helped to bring point, delicacy, and irony into our prose writing. He was the "Jotham, of piercing wit and pregnant thought" in Dryden's *Absalom and Achitophel*. When party passion drove him from public life temporarily—though he returned to steer the ship of State when storms threatened—he busied himself with writing. His *Character of Charles the Second* is the closest personal study of that monarch; his *Advice to a Daughter* is full of condensed wisdom; his *Letter to a Dissenter*, warning the Nonconformists not to be the cat's paw of King James, gave a turn to the helm at an important crisis in our history; and his description of *The Character of a Trimmer*—his own character—is not only an everlasting lesson in public polity, but remains a model of the clearness that convinces, and the irony that makes obstinacy ashamed. Here is his description of the despised Trimmer, or central man in politics:—

"This innocent word 'Trimmer' signifies no more than this, that if men are together in a boat, and one part of the company would weigh it down on one side, and another would make it lean as much on the contrary, it happeneth there is a third opinion of those who conceive it would do as well if the boat went even, without endangering the passengers. Now, it is hard to imagine by what figure in language, or by what rule in sense, this cometh to be a fault, and it is much more a wonder it should be thought a heresy. But it so happeneth that the poor Trimmer hath now all the powder spent on him alone. There is no danger now to the State but from the beast called a Trimmer."

From the painting by Sir Peter Lely.

DOROTHY OSBORNE,

whose letters to Sir William Temple are among the brightest examples of correspondence in English literature. The letters, which describe delightfully the life of a seventeenth-century English girl, were not published till 1888.

This is how the argument closes:—

"Our Trimmer thinks fit to conclude with these assertions: that our climate is a trimmer between that part of the world where men are roasted and the other where they are frozen; that our church is a trimmer between the frenzy of fanatic visions and the lethargic ignorance of popish dreams; that our laws are trimmers between the excess of unbounded power and the extravagance of liberty not enough restrained; that true virtue hath ever been thought a trimmer and to have its dwelling between the two extremes; that even Almighty God himself is divided between His two great attributes, His mercy and justice. In such company our Trimmer is not ashamed of his name, and willingly leaveth to the bold champions of either extreme the honour of contending with no less adversaries than nature, religion, liberty, prudence, humanity, and commonsense."

Roger North (1653–1734), who only came into his full reputation towards the close of the 19th century, through the researches of Dr. Augustus Jessopp, was a prosperous lawyer who, in retirement in Norfolk, wrote the lives of his three brothers and his own autobiography. The brothers were Francis North, Lord Guilford, Keeper of the Great Seal; Sir Dudley North, merchant, of the Turkey Company, Constantinople; and Dr. John North, master of Trinity College, Cambridge. The *Autobiography*, published

in 1887, and the *Lives*, attractively written, give us a familiar inside view of much interesting life of a kind not often reached by formal histories. Roger North also wrote, in his *Examen*, a criticism of a contemporary history of England. His object was "to vindicate the honour of Charles II. and his happy reign," which he regarded as

From the portrait by John Hayle. Photo: Emery Walker, Ltd.

SAMUEL PEPYS (1633–1703),

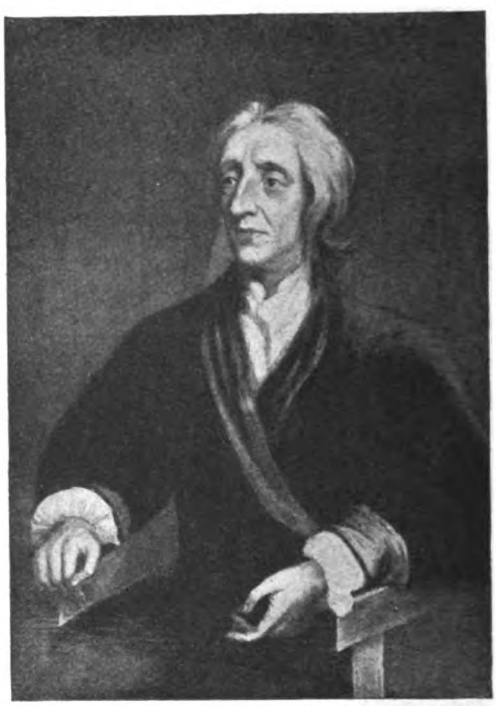
whose *Diary* stands alone in the world of books. A portrait of the author at the age of thirty-three.

aspersed. The history by Kenneth, afterwards Bishop of Peterborough, and the reply by North are pretty examples of contemporary partisanship.

John Evelyn (1620–1706) and Samuel Pepys (1633–1703), the best known of English diarists, were friends. Evelyn, a gentleman of wealth and standing, filled various public offices with honour, but was primarily a writer. His gracefully but somewhat formally written *Diary* tells the story of his life, including his early travels, when he arranged to be out of the country in difficult times. It throws an invaluable illumination over a period beclouded with the dust of partisan conflict. It was not published till 1818.

Samuel Pepys was only incidentally a man of letters. His *Diary*—a book that stands alone in the world of books—was written in cipher for his own use, and was not transcribed fully till 153 years after it was closed in 1669 under the fear of blindness caused by writing the cipher. Pepys, however, lived more than thirty-three years longer, and did not lose his sight. The *Diary*, which pictures him as a steadily rising clerk in the Navy Office, under the patronage of his kinsman the Earl of Sandwich, does not follow him to the height of his prosperity. He finally became Secretary to the Admiralty and a most able naval reformer.

The *Diary* gains its lasting charm from the insatiable interest which Pepys felt in every phase of life, and the complete candour and simplicity of his record, without any trace of self-consciousness in the mode of expression. It is because there is no thought of style that the style is perfect for its purpose. The spectacle of a man turning his heart inside out is so unusual that the



By permission of the Dean and Governing Body, Christ Church, Oxford.

JOHN LOCKE (1632–1704),

whose writings, although they belong to the domain of philosophy rather than that of pure literature, had an influence on European thought more far-reaching than those of any man before Herbert Spencer.

confessions arrest attention unduly, and the diarist's admitted weaknesses, which were never meant for our censure, are all arrayed against him, and we are in danger of forgetting that Samuel Pepys was an energetic, able servant of his country.

As an illustration of the style of Pepys in his *Diary*, we may quote his references to

Butler's *Hudibras*, in the year when it was published (1662) and the following year :—

December 26th. Up, my wife to the making of Christmas pies all day, doing now pretty well again; and I abroad to several places about some businesses, among others bought a bake-pan in Newgate Market, and sent it home. It cost me 16s. So to Dr. Williams, but he is out of town, then to the wardrobe. Hither come Mr. Battersby, and we falling into discourse of a new book of drollery in use, called *Hudibras*, I would needs go find it out, and met with it at the Temple; cost me 2s. 6d. But when I come to read it, it is so silly an abuse of the Presbyter knight going to the wars that I am ashamed of it, and by and by meeting at Mr. Townsend's at dinner I sold it to him for 18d.

February 6th. To Lincoln's Inn Fields, and it being too soon to go to dinner, I walked up and down and looked upon the outside of the new theatre now a-building in Covent Garden, which will be very fine. And so to a bookseller's in the Strand, and there bought *Hudibras* again, it being certainly some ill-humour to be so against that which all the world cries up to be the example of wit, for which I am resolved once more to read him, and see whether I can find it or no.

November 28th. Abroad to St. Paul's Churchyard, and there looked upon the second part of *Hudibras*, which I buy not, but borrow to read, to see if it be as good as the first, which the world cry so mightily up, though it hath not a good liking in me, though I had tried by twice or three times reading to bring myself to think it witty.

From the picture by E. M. Ward, R.A., in the National Gallery.

THE FALL OF CLARENDON.

The first great English historian, Lord Clarendon, was Chancellor under Charles II., and for a long time the King's favourite minister. His attempts to improve the moral tone of the Court earned for him his royal master's displeasure, and did as much as anything to bring about his fall. Above is shown the close of the final audience at Whitehall—the King walking away towards the garden gate, the Chancellor descending the stairs, proudly ignoring the triumphant or inquisitive stares of numerous courtiers.

Edward Hyde, Earl of Clarendon (1608-1674), originally a commoner of good estate, is equally notable as a maker and a writer of history. A successful lawyer, who loved literary society and the use of his pen, he first became a man of mark on the Parliamentary side, but when he thought the arbitrary tendencies of Charles I. had been sufficiently checked passed over to the King's party and became one of Charles's confidential advisers and the writer of the royal proclamations. During the Civil War Ned Hyde (as Charles called him) was given the guardianship of Prince Charles, and while in the Scilly Islands and Jersey, in

retirement, wrote a *History of the Rebellion* to the year 1644, which he kept by him. During the Commonwealth period he lived chiefly in Paris, a faithful manager of the embarrassed exchequer of the exiled Prince, and later Secretary of State. At the Restoration, Hyde was appointed Lord Chancellor, and was created Earl of Clarendon. By the marriage of his daughter to James, Duke of York, afterwards James II., she and two of her daughters became, in succession, queens of England, Mary as wife of William of Orange, and Anne on her own account.

For seven years Clarendon, more than any other man, governed England, and accumulated such unpopularity that in 1667 he was dismissed into exile, from which he never returned. He died at Rouen in 1674. During the early part of this seven years' final exile he wrote a Life of himself, for his children. Later he amalgamated his early fragmentary history and his Autobiography, adding chapters to make them fit and to round off the narrative up to the year 1660. This composite work, published in 1702, is the classical *History of the Rebellion*. In 1759 was published *The Life of Edward, Earl of Clarendon*. This book consists of such portions of the original Life before 1660 as had not been used in the History, and a continuation tracing Clarendon's political work after the Restoration, and the personal story of the second exile.

Clarendon's *History*

Clarendon was the first great English historian. It is true that his writing is singularly unequal, planned in wrong proportions, often biased, and sometimes almost contradictory; but these faults are caused by the history being compounded from writings of different periods, penned in varying moods, for diverse objects; and allowance must be made for the limitations of the writer and his persistence in defending himself. On four points Clarendon was rigid, and they were points that annoyed, in turn, every section of the community and left him friendless. He demanded legality from kings, and this the kings did not like. He could see no good in any religion except that of the English Episcopacy, and was ready to be a persecutor on its behalf against Catholicism; Presbyterianism, and every form of Dissent. He distrusted and thwarted Roman Catholicism, though two of the Stuarts were Catholics and two of them had Catholic wives. And he was a strict and protesting moralist, and an honest man in a corrupt and dissolute age. The women of the Court, from the queens downward, were his enemies. The Stuart kings, whom he served with fidelity and frankness, repeatedly deceived him when their wishes coincided with the advice of other counsellors, and finally Charles II. sacrificed him ruthlessly as a scapegoat when unpopularity began to gather ominously.

His ruin came largely from inability to see the points of view of other men. To the end his belief in himself was unshaken. Rigidity and blindness in an honest and self-sufficient man appear in his writings as plainly as in his statesmanship. His history is a constant attempt to vindicate his own particular views, and his many character sketches must always be tempered by a knowledge of his personal relations with the man he is describing.

John Locke

John Locke (1632–1704), of all the known men of his generation, had the most characteristically English mind. Living near the storm centre, in an age which tested character perhaps more severely than it has been tested in any other epoch, he stands forth clear from all reproach. An Oxford scholar till he was flung from the University as a friend of Shaftesbury, in 1683, by order of Charles II., he remained in exile in Holland till the Revolution of 1688. He had spent a lifetime in thought, and was fifty-seven years old when his first book, *A Letter on Toleration*, was published, insisting on the right of every man to hold and express his own opinions on all questions, including religion, without molestation, since the repression of opinion must be detrimental to truth. Between 1689 and 1693 followed his *Essay on Human Understanding*, arguing that we are not born with certain innate ideas, but derive all our knowledge either from the external world through the senses, or from reflection; his *Treatise on Civil Government*, suggesting that civil government should be controlled by the people, and exists to promote the happiness of the individual; and his *Thoughts on Education*, insisting that education should be broadened to include history and science, but that physical well-being and moral elevation are more important than acquisition of knowledge. Locke's writings belong to the domain of philosophy rather than that of pure literature. In style, they purposely discarded all ornament, and aimed at expressing thought in the fewest words with the utmost clearness. J. D.

Continued from page 5.

HISTORY:

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BRITAIN'S STORY.—VI

[*The introduction to* LORD MACAULAY'S "*History of England*" *has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages* (*printed in closer type*) *have been interpolated in order to meet the requirements of the student.*]

THAT the political institutions of England in the fourteenth century were regarded by the English with pride and affection, and by the most enlightened men of neighbouring nations with admiration and envy, is proved by the clearest evidence. But touching the nature of those institutions there has been much dishonest and acrimonious controversy.

The present constitution of our country is, to the constitution under which she flourished six hundred years ago, what the tree is to the sapling, what the man is to the boy. The alteration has been great. Yet there never was a moment at which the chief part of what existed was not old.

An Elastic Constitution

A polity thus formed must abound in anomalies. But for the evils arising from mere anomalies we have ample compensation. Other societies possess written constitutions more symmetrical. But no other society has yet succeeded in uniting revolution with prescription, progress with stability, the energy of youth with the majesty of immemorial antiquity.

This great blessing, however, has its drawbacks: and one of those drawbacks is that every source of information as to our early history has been poisoned by party spirit.

A Frenchman is not now impelled by any strong interest either to exaggerate or to underrate the power of the Kings of the House of Valois. The privileges of the States-General, of the States of Brittany, of the States of Burgundy, are to him matters of as little practical importance as the constitution of the Jewish Sanhedrim or of the Amphictyonic Council. The gulf of a great revolution completely separates the new from the old system.

No such chasm divides the existence of the English nation into two distinct parts. Our laws and customs have never been lost in general and irreparable ruin. With us the precedents of the middle ages are still valid precedents, and are still cited on the gravest occasions by the most eminent statesmen.

Party Historians

For example, when King George III.* was attacked by the malady which made him incapable of performing his regal functions, and when the most distinguished lawyers and politicians differed widely as to the course which ought, in such circumstances, to be pursued, the Houses of Parliament would not proceed to discuss any plan of regency till all the precedents which were to be found in our annals, from the earliest times, had been collected and arranged. Committees were appointed to examine the ancient records of the realm. The first case reported was that of the year 1217: much importance was attached to the cases of 1326, of 1377, and of 1422: but the case which was justly considered as most in point was that of 1455.

Thus in our country the dearest interests of parties have frequently been staked on the results of the researches of antiquaries. The inevitable consequence was that our antiquaries conducted their researches in the spirit of partisans.

It is therefore not surprising that those who have written concerning the limits of prerogative and liberty in the old polity of

* When George III. went mad in 1788, the Prince of Wales claimed as his right the powers of Regent. Pitt, however, successfully maintained the constitutional view that the choice of a Regent was the undoubted privilege of Parliament.

England should generally have shown the temper, not of judges, but of angry and uncandid advocates. From the commencement of the long contest between the Parliament and the Stuarts down to the time when the pretensions of the Stuarts ceased to be formidable, few questions were practically more important than the question whether the administration of that family had or had not been in accordance with the ancient constitution of the kingdom. This question could be decided only by reference to the records of preceding reigns.

Both parties looked into the chronicles of the middle ages. Both readily found what they sought; and both obstinately refused to see anything but what they sought. The champions of the Stuarts could easily point out instances of oppression exercised on the subject. The defenders of the Roundheads could as easily produce instances of determined and successful resistance offered to the Crown.

The English Monarchy

Those who saw only one half of the evidence would have concluded that the Plantagenets were as absolute as the Sultans of Turkey: those who saw only the other half would have concluded that the Plantagenets had as little real power as the Doges of Venice; and both conclusions would have been equally remote from the truth.

The old English government was one of a class of limited monarchies which sprang up in Western Europe during the middle ages, and which, notwithstanding many diversities, bore to one another a strong family likeness. That there should have been such a likeness is not strange. The countries in which those monarchies arose had been provinces of the same great civilised empire, and had been overrun and conquered, about the same time, by tribes of the same rude and warlike nation.

They were members of the same great coalition against Islam. They were in communion with the same superb and ambitious Church. Their polity naturally took the same form. They had institutions derived partly from imperial Rome, partly from papal Rome, partly from the old Germany.

All had Kings; and in all the kingly office became by degrees strictly hereditary. All had nobles bearing titles which had originally indicated military rank. The dignity of knighthood, the rules of heraldry, were common to all. All had richly endowed ecclesiastical establishments, municipal corporations enjoying large franchises, and senates whose consent was necessary to the validity of some public acts.

Of these kindred constitutions the English was, from an early period, justly reputed the best.

The prerogatives of the sovereign were undoubtedly extensive. The spirit of religion and the spirit of chivalry concurred to exalt his dignity. The sacred oil had been poured on his head. It was no disparagement to the bravest and noblest knights to kneel at his feet. His person was inviolable. He alone was entitled to convoke the Estates of the realm: he could at his pleasure dismiss them; and his assent was necessary to all their legislative acts. He was the chief of the executive administration, the sole organ of communication with foreign powers, the captain of the military and naval forces of the State, the fountain of justice, of mercy, and of honour. He had large powers for the regulation of trade.

It was by him that money was coined, that weights and measures were fixed, that marts and havens were appointed. His ecclesiastical patronage was immense.

Royal Prerogative

His hereditary revenues, economically administered, sufficed to meet the ordinary charges of government. His own domains were of vast extent. He was also feudal lord paramount of the whole soil of his kingdom, and, in that capacity, possessed many lucrative and many formidable rights, which enabled him to annoy and depress those who thwarted him, and to enrich and aggrandise, without any cost to himself, those who enjoyed his favour.

But his power, though ample, was limited by three great constitutional principles. First, he could not legislate without the consent of his Parliament. Secondly, he could impose no tax without the consent of his Parliament. Thirdly, he was bound to conduct the executive administration according to the laws of the land, and, if he broke those laws, his advisers and his agents were responsible.

No candid Tory will deny that these principles had, six hundred years ago, acquired the authority of fundamental rules. On the other hand, no candid Whig will affirm that they were, till a later period, cleared from all ambiguity, or followed out to all their consequences. In rude societies the progress of government resembles the progress of language and of versification. As eloquence exists before syntax, and song before prosody, so government may exist in a high degree

From the drawing by Sir John Gilbert.

DEATH OF KING RICHARD II. (1400).

During the 160 years preceding the union of the Roses, nine kings reigned in England. Of these, six were deposed, and five lost their lives as well as their crowns. The manner of Richard II.'s death is an "historical mystery"; some say he was starved, others that he was sent violently to death, by his guards at Pontefract Castle.

of excellence long before the limits of legislative, executive, and judicial power have been traced with precision.

It was thus in our country. The line which bounded the royal prerogative, though in general sufficiently clear, had not everywhere been drawn with accuracy and distinctness. There was, therefore, near the border some debatable ground on which incursions and reprisals continued to take place, till, after ages of strife, plain and durable landmarks were at length set up.

It may be instructive to note in what way, and to what extent, our ancient sovereigns were in the habit of violating the three great principles by which the liberties of the nation were protected.

Constitutional Safeguards

No English King has ever laid claim to the general legislative power. The most violent and imperious Plantagenet never fancied himself competent to enact, without the consent of his great council, that a jury should consist of ten persons instead of twelve, that a widow's dower should be a fourth part instead of a third, that perjury should be a felony, or that the custom of gavelkind should be introduced into Yorkshire.

But the King had the power of pardoning offenders; and there is one point at which the power of pardoning and the power of legislating seem to fade into each other, and may easily, at least in a simple age, be confounded. The sovereign was undoubtedly competent to remit penalties without limit. He was therefore competent to annul virtually a penal statute. Thus, with the help of subtle and courtly lawyers, grew up, on the doubtful frontier which separates executive from legislative functions, that great anomaly known as the dispensing power.

That the King could not impose taxes without the consent of Parliament is admitted to have been, from time immemorial, a fundamental law of England. It was among the articles which John was compelled by the barons to sign.

Edward I. ventured to break through the rule: but able, powerful and popular as he was, he encountered an opposition to which he found it expedient to yield. He covenanted accordingly in express terms, for himself and his heirs, that they would never again levy any aid without the assent and goodwill of the Estates of the realm. His powerful and victorious grandson attempted to violate this solemn compact: but the attempt was strenuously withstood.

At length the Plantagenets gave up the point in despair: but, though they ceased to infringe the law openly, they occasionally contrived, by evading it, to procure an extraordinary supply for a temporary purpose. They were interdicted from taxing; but they claimed the right of begging and borrowing. They therefore sometimes begged in a tone not easily to be distinguished from that of command, and sometimes borrowed with small thought of repaying. But the fact that they thought it necessary to disguise their exactions under the names of benevolences and loans sufficiently proves that the authority of the great constitutional rule was universally recognised.

The principle that the King of England was bound to conduct the administration according to law, and that, if he did anything against law, his advisers and agents were answerable, was established at a very early period, as the severe judgments pronounced and executed on many royal favourites sufficiently prove. It is, however, certain that the rights of individuals were often violated by the Plantagenets, and that the injured parties were often unable to obtain redress.

Liberty of the Subject

According to law, no Englishman could be arrested or detained in confinement merely by the mandate of the sovereign. In fact, persons obnoxious to the government were frequently imprisoned without any other authority than a royal order. According to law, torture, the disgrace of the Roman jurisprudence, could not, in any circumstances, be inflicted on an English subject. Nevertheless, during the troubles of the fifteenth century, a rack was introduced into the Tower, and was occasionally used under the plea of political necessity.

But it would be a great error to infer from such irregularities that the English monarchs were, either in theory or in practice, absolute. We live in a highly civilised society, through which intelligence is so rapidly diffused by means of the press and of the post office that any gross act of oppression committed in any part of our island is, in a few hours, discussed by millions. If the sovereign were now to immure a subject in defiance of the writ of Habeas Corpus, or to put a conspirator to the torture, the whole nation would be instantly electrified by the news.

In the middle ages the state of society was widely different. Rarely, and with great difficulty, did the wrongs of individuals come to the knowledge of the public. Nor

were our ancestors by any means so much alive as we are to the importance of maintaining great general rules. We have been taught by long experience that we cannot without danger suffer any breach of the constitution to pass unnoticed.

But such were not the feelings of the Englishmen of the fourteenth and fifteenth centuries. They were little disposed to contend for a principle merely as a principle. As long as the general spirit of the administration was mild and popular, they were willing to allow some latitude to their sovereign.

But to this indulgence there was a limit; nor was that King wise who presumed far on the forbearance of the English people. They might sometimes allow him to overstep the constitutional line; but they also claimed the privilege of overstepping that line themselves, whenever his encroachments were so serious as to excite alarm.

Ancient and Modern Polity

Our forefathers might indeed safely tolerate a King in a few excesses; for they had in reserve a check which soon brought the fiercest and proudest King to reason, the check of physical force. In the middle ages resistance was an ordinary remedy for political distempers, a remedy which was always at hand, and which, though doubtless sharp at the moment, produced no deep or lasting ill effects. Society recovered from the shock as soon as the actual conflict was over. The calamities of civil war were confined to the slaughter on the field of battle, and to a few subsequent executions and confiscations. In a week the peasant was driving his team and the esquire flying his hawks over the field of Towton or of Bosworth, as if no extraordinary event had interrupted the regular course of human life.

Not since 1688 have the English people by force subverted a government. During the hundred and sixty years which preceded the union of the Roses, nine Kings reigned in England. Six of these nine Kings were deposed. Five lost their lives as well as their crowns.* It is evident, therefore, that any comparison between our ancient and our modern polity must lead to most erroneous conclusions, unless large allowance be made for the effect of that restraint which resistance and the fear of resistance constantly imposed on the Plantagenets.

* Edward II., Richard II., Henry VI., Edward V., and Richard III., all were deposed and lost their lives. Edward IV. also lost his crown for a while—in 1470, when Warwick, the King-maker, deserted him and restored Henry VI. to the throne.

As our ancestors had against tyranny a most important security which we want, they might safely dispense with some securities to which we justly attach the highest importance. As we cannot, without the risk of evils from which the imagination recoils, employ physical force as a check on misgovernment, it is evidently our wisdom to keep all the constitutional checks on misgovernment in the highest state of efficiency, to watch with jealousy the first beginnings of encroachment, and never to suffer irregularities, even when harmless in themselves, to pass unchallenged. Four hundred years ago such minute vigilance might well seem unnecessary. A nation of hardy archers and spearmen might, with small risk to its liberties, connive at some illegal acts on the part of a prince whose general administration was good, and whose throne was not defended by a single company of regular soldiers.

Under this system, rude as it may appear when compared with those elaborate constitutions of which recent years have been fruitful, the English long enjoyed a large measure of freedom and happiness. Though, during the feeble reign of Henry VI. the State was torn, first by factions, and at length by civil war; though Edward IV. was a prince of dissolute and imperious character; though Richard III. has generally been represented as a monster of depravity; though the exactions of Henry VII.* caused great repining; it is certain that our ancestors, under those Kings, were far better governed than the Belgians under Philip, surnamed the Good, or the French under Lewis who was styled the Father of his people.

England's Superiority

Even while the Wars of the Roses were actually raging, our country appears to have been in a happier condition than the neighbouring realms during years of profound peace. Comines was one of the most enlightened statesmen of his time. He had seen all the richest and most highly civilised parts of the Continent. He had lived in the opulent towns of Flanders, the Manchesters and Liverpools of the fifteenth century. He had visited Florence, recently adorned by the magnificence of Lorenzo, and Venice, not yet humbled by the Confederates of Cambray.

This eminent man deliberately pronounced England to be the best governed country of which he had any knowledge. Her constitution he emphatically designated as a just

* The exactions of Henry VII. comprised subsidies granted for the support of wars which he evaded, fines, and forced gifts.

and holy thing, which, while it protected the people, really strengthened the hands of a prince who respected it. In no other country, he said, were men so effectually secured from wrong. The calamities produced by our intestine wars seemed to him to be confined to the nobles and the fighting men, and to leave no traces such as he had been accustomed to see elsewhere, no ruined dwellings, no depopulated cities.

Noble and Plebeian

It was not only by the efficiency of the restraints imposed on the royal prerogative that England was advantageously distinguished from most of the neighbouring countries. A peculiarity equally important, though less noticed, was the relation in which the nobility stood here to the commonalty. There was a strong hereditary aristocracy: but it was of all hereditary aristocracies the least insolent and exclusive. It had none of the invidious character of a caste. It was constantly receiving members from the people, and constantly sending down members to mingle with the people.

Any gentleman might become a peer. The younger son of a peer was but a gentleman. Grandsons of peers yielded precedence to newly made knights. The dignity of knighthood was not beyond the reach of any man who could by diligence and thrift realise a good estate, or who could attract notice by his valour in a battle or a siege. It was regarded as no disparagement for the daughter of a Duke, nay of a royal Duke, to espouse a distinguished commoner. Thus, Sir John Howard married the daughter of Thomas Mowbray, Duke of Norfolk. Sir Richard Pole married the Countess of Salisbury, daughter of George, Duke of Clarence.

Good blood was indeed held in high respect: but between good blood and the privileges of peerage there was, most fortunately for our country, no necessary connection. Pedigrees as long, and scutcheons as old, were to be found out of the House of Lords as in it.

Class Equality

There were new men who bore the highest titles. There were untitled men well known to be descended from knights who had broken the Saxon ranks at Hastings, and scaled the walls of Jerusalem. There were Bohuns, Mowbrays, De Veres, nay, kinsmen of the House of Plantagenet, with no higher addition than that of Esquire, and with no civil privileges beyond those enjoyed by every farmer and shopkeeper.

There was therefore here no line like that which in some other countries divided the patrician from the plebeian. The yeoman was not inclined to murmur at dignities to which his own children might rise. The grandee was not inclined to insult a class into which his own children must descend.

From the painting by Daniel Maclise, R.A.

IN THE BARON'S HALL.

This picture, purchased for the National Gallery of Ireland, shows many of the probable incidents of a thirteenth century Christmas feast: the arrival of the boar's head on a silver platter; two conjurers performing; Father Christmas regaling himself at the punch-bowl; a group of waiting-maids playing hunt-the-thimble. The Baron, his family, and the guests of rank can be seen seated at the table on the dais in the background.

Continued from page 25.

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CHEMISTRY.—XVIII

The Oxides of Nitrogen and Ammonia.—We have already learnt that nitrogen peroxide is evolved during the decomposition of nitric acid, and it is also formed when almost any nitrate is decomposed by heat.

Experiment LI.—*Preparation and liquefaction of nitrogen peroxide.*

The nitrate usually selected for this purpose is lead nitrate:—

$$2\,Pb(NO_3)_2 = 2\,PbO + 4NO_2 + O_2.$$

The substance is finely ground in a mortar, dried in an oven at about 100°, and then put into a dry retort, which is connected with a dry condensing tube immersed in a freezing mixture of ice and salt.

The retort is heated gently at first, and then more strongly. The brownish-red fumes of nitrogen peroxide pass down the neck of the retort into the condensing tube, where they liquefy.

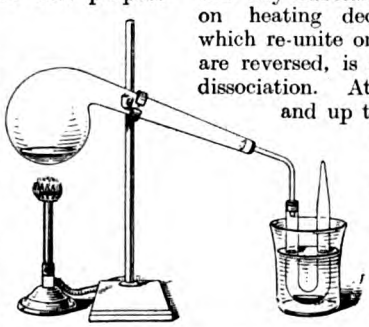


Fig. 26.—Apparatus for preparing and liquefying nitrogen peroxide.

At lower temperatures the liquid forms crystals; it boils at 22° C.

The analysis of this compound shows that its empirical formula is NO_2. The determination of the molecular weight is rendered difficult by the fact that the vapour density varies at different temperatures; the colour also changes with the temperature, passing from light yellow, through red and brown, to almost complete blackness. Neither the density nor the colour alter after 140° C. has been reached.

The changes enumerated above are explained by the assumption that the gas consists chiefly of N_2O_4 (nitrogen tetroxide) molecules at low temperatures and that these decompose into molecules of NO_2 (nitrogen dioxide) as the temperature rises.

At 140° and above the density corresponds to a molecular weight of 46, showing that only NO_2 molecules exist at and above this temperature. Similar changes occur if the pressure be altered and the temperature be kept constant; also the same changes take place, but in the reversed order, when the oxide is cooled down from 140°.

The equation for this *reversible change* is written as follows:—

$$N_2O_4 \rightleftharpoons NO_2 + NO_2,$$

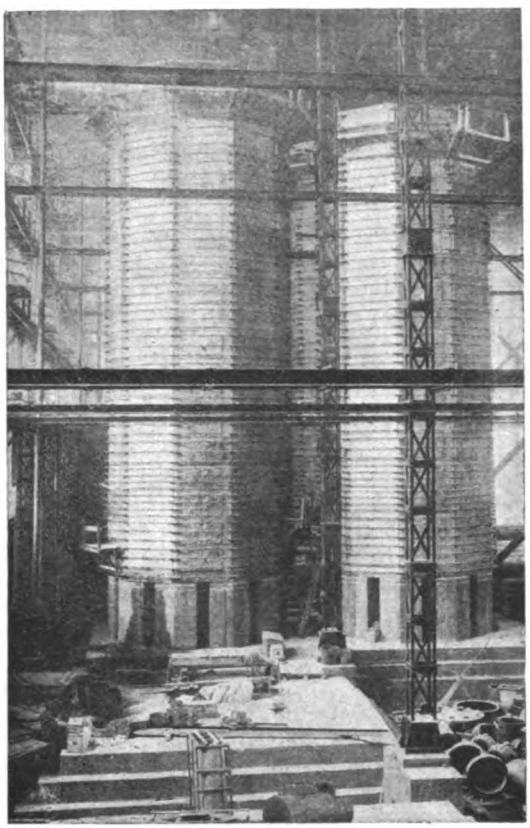
and any substance like nitrogen peroxide, which on heating decomposes into other substances which re-unite on cooling, or when the conditions are reversed, is said to *dissociate*, or to undergo dissociation. At the ordinary temperature, then, and up to 140°, nitrogen peroxide consists of two kinds of molecules; above 500° it is separated into nitric oxide, NO, and free oxygen.

Properties of Nitrogen Peroxide.—It is a heavy, poisonous gas with a disagreeable smell. It neither burns nor supports the combustion of a taper, but if strongly ignited sulphur, carbon, or phosphorus be put into it, they will continue to burn with vigour because the heat they emit decomposes the gas into its elements, and then they combine with the liberated oxygen and leave the nitrogen free. It is a good oxidising agent. It dissolves readily in cold water to form nitric and nitrous acids, $2NO_2 + H_2O = HNO_3 + HNO_2$, and in caustic alkalis to produce a nitrate and a nitrite: $2NO_2 + 2KOH = KNO_3 + KNO_2 + H_2O$. With warm water, nitric acid and nitric oxide are formed: $3NO_2 + H_2O = 2HNO_3 + NO$.

The production of nitric acid from nitrogen peroxide and water is of great industrial importance, as it affords a means of "fixing" nitrogen, i.e., converting the free nitrogen of the air into a compound which can be used for human purposes. An alternating current of about 5,000 volts is passed between copper electrodes situated in the

field of a very powerful magnet which causes the flame to spread out like a fan. Air is blown through, the nitric oxide produced is cooled rapidly, and it then combines with atmospheric oxygen to form the peroxide. The latter is absorbed in water to which lime is added, and the resulting product, calcium nitrate ("nitrolim") finds a ready market as a valuable fertiliser, as it contains nitrogen in a form immediately available for plant life.

Nitrogen Trioxide is a relatively unimportant oxide. It is made by passing a dried



PRODUCING CALCIUM NITRATE.

For commercial purposes the nitrogen (see opposite) takes the form of calcium nitrate, produced by absorbing nitrogen peroxide in lime and water in the granite towers shown above.

mixture of nitric oxide and nitrogen peroxide through a vessel cooled to — 30°. It forms a blue liquid which decomposes rapidly when the temperature is raised. $NO + NO_2 \rightleftarrows N_2O_3$. Its chief importance lies in the fact that it is the anhydride of nitrous acid. With a little water it reacts thus: $N_2O_3 + H_2O = 2HNO_2$. Nitrous acid, HNO_2, is only known in aqueous solution. When the solution is warmed, the acid decomposes into nitric oxide and nitric acid: $3HNO_2 = 2NO + HNO_3 + H_2O$. The nitric oxide is a reducing agent and the nitric acid an oxidising agent, hence a solution containing nitrous acid, such as is obtained by acidifying a solution of a nitrite, both reduces and oxidises.

Nitric Oxide is an interesting and important substance, as it combines with free oxygen at the ordinary temperature to form nitrogen peroxide: $2NO + O_2 = 2NO_2$; and because it is produced in many reactions in which nitric acid takes part. It is difficult to prepare in the pure state, the reaction usually employed for its production being far more complex than the following equation indicates: $3Cu + 8HNO_3 = 3Cu(NO_3)_2 + 2NO + 4H_2O$.

Experiment LII.—*To prepare and examine nitric oxide.*

(i) The apparatus may be either that used for preparing hydrogen (Experiment XIX.) or a large tubulated retort connected to a trough containing water, etc. Copper turnings are put into the vessel selected, and somewhat diluted nitric acid (4 of acid to 1 of water) are added. Red fumes are immediately evolved; these are partly formed by the interaction of acid and metal, and partly by the oxidation of the nitric oxide evolved. The nitrogen peroxide dissolves in the water in the trough, and the nitric oxide is collected in gas-jars.

(ii) On removing the cover from a jar, the immediate production of nitrogen peroxide is observed.

(iii) A jar is partly filled with nitric oxide, and then bubbles of oxygen are slowly admitted. As these enter, the water sinks and brown fumes appear; the latter dissolve quickly, and the water then rises to a higher level than before. By careful experimenting it is possible to eliminate all gas from the jar.

(iv) A jar of gas is inverted in water contained in a basin. The water does not rise perceptibly, showing that the gas does not dissolve to any extent.

(v) A lighted taper is lowered into the gas; it is extinguished.

(vi) Burning sulphur and glowing charcoal are also extinguished.

(vii) Phosphorus burning feebly in a deflagrating spoon is lowered into nitric oxide; it ceases to burn. It is withdrawn and made to burn vigorously and then put back again. It burns brightly, producing white fumes of phosphoric oxide and leaving nitrogen: $4P + 10NO = 2P_2O_5 + 5N_2$. In this case sufficient heat is evolved to decompose the gas into its elements, and the phosphorus burns in the liberated oxygen.

(viii) Some nitric oxide is either passed into, or shaken with, a clear solution of ferrous sulphate. The gas is absorbed and the liquid darkens owing to the formation of the unstable compound $2FeSO_4NO$. If the solution be warmed, the nitric oxide is evolved in a state of purity. The impurities originally in the gas did not dissolve in the ferrous sulphate.

Owing to the facility with which nitric oxide combines with oxygen, it is a good reducing agent, but it can also function as an oxidising agent, e.g., when it is passed over heated copper. (Write the equation.)

Nitrous Oxide, N_2O, is well known to civilised man as the anæsthetic used by the dentist in extracting refractory teeth. It is sometimes called "laughing gas," because it occasionally produces symptoms of hilarity in the patient. As it does not support life, its administration must not

exceed about 40 seconds, but if it be mixed with oxygen it may be used for a prolonged operation; in fact, such a mixture constitutes one of the safest anæsthetics for all kinds of operations, but it needs to be applied with skill.

Experiment LIII.—*The preparation and properties of nitrous oxide.*

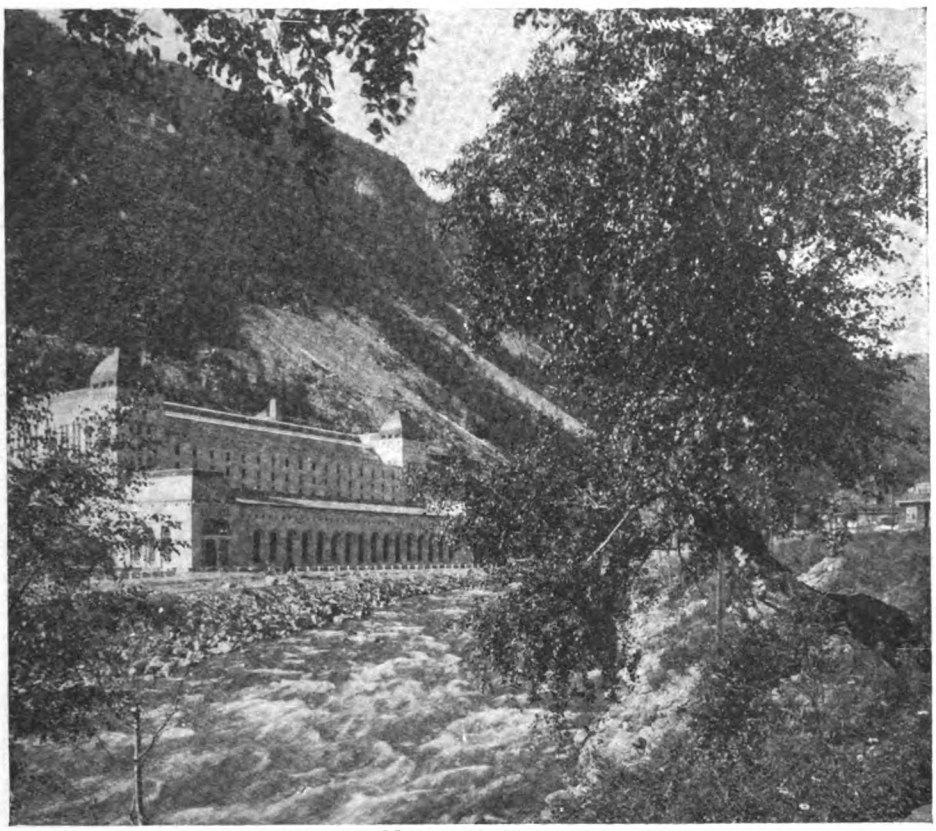
(i) Nitrous oxide is made by carefully heating ammonium nitrate, a white crystalline solid, in a round-bottomed flask, connected by a tube to a trough of water.

$$N H_4 N O_3 = N_2 O + 2 H_2 O.$$

The flask must be cautiously heated, otherwise an explosion may ensue. As nitrous oxide is appreciably soluble in cold water, warm water should be used for its collection.

(ii) *et seq.* The student should perform similar experiments to those carried out with nitric oxide, carefully noting the differences between the two.

Nitrous oxide is a colourless gas with a slight smell. It is not altered by contact with the air, and it is not combustible. It supports the combustion of a taper and of phosphorus; but feebly burning sulphur is extinguished. (Write the equations for the reactions involved.) It is important to note that it will re-kindle a glowing splint of wood, resembling oxygen in this respect; but it can be distinguished from the latter by the fact that it does not produce nitrogen peroxide when brought into contact with nitric oxide. As it does not unite with ferrous sulphate, it may be purified from admixed nitric oxide by passing it through a solution of this salt. When passed over heated copper it gives copper oxide and nitrogen, the volume of the latter being the same as that of the oxide of nitrogen: $N_2 O + Cu = Cu O + N_2$. Nitrous oxide comes into commerce in the liquid state enclosed in steel cylinders; it is liquefied at 0° C. under a pressure of 30 atmospheres.



WRESTING NITROGEN FROM NATURE.

In Norway, on the lower level of the Rjukan-fos (Smoking Cascade), Maanely River, there is a large hydro-electric power station which supplies the current to work the "arc process" of fixing atmospheric nitrogen (*vide* pp. 69–70), the most valuable of fertilizers of the soil, hitherto available only in the form of guano, nitrate of soda, and nitrate of potash. The power station develops 162,000 h.p.

Ammonia, $N H_3$, is a colourless gas of very powerful odour, lighter than air (0·6 : 1), very soluble in water, and possessing a strongly alkaline reaction. Very small quantities are found in the air and in fresh waters, chiefly in the combined state, and it is formed in the soil by the action of specific bacteria upon certain kinds of organic matter containing nitrogen. It is produced artificially during the manufacture of coal gas:

the latter is purified from ammonia by washing it with water, and the impure wash-water ("ammoniacal liquor") is used for making sulphate of ammonia, a very important fertiliser.

Many nitrogenous organic compounds evolve ammonia on heating, particularly in presence of lime or other alkali, and this fact may be used as a test for nitrogen in organic combination. By the

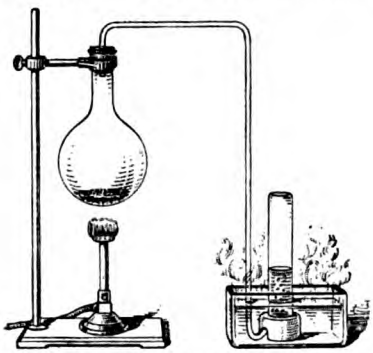


Fig. 27.—Apparatus for preparing nitrous oxide (*see page* 71).

passage of electric sparks through nitrogen and hydrogen, mixed in the proportions of 1 : 3, about 2 per cent. of the mixture is converted into ammonia; the reaction is a reversible one: $N_2 + 3H_2 \rightleftarrows 2NH_3$. In the presence of water, the ammonia is removed as fast as it is formed, and then the change proceeds continuously.

Haber's process for the industrial production of ammonia consists in passing the gases under a pressure of 200 atmospheres over a heated catalyst, e.g., platinum or osmium, and removing the ammonia as fast as it is formed. The Germans fixed enormous quantities of atmospheric nitrogen by this process during the war.

Experiment LIV.—*To make and investigate ammonia.*

(i) The laboratory method of preparing this gas is by heating ammonium chloride ("salammoniac") or other ammonium compound with lime or other alkali.

$2NH_4Cl + CaO = 2NH_3 + CaCl_2 + 2H_2O$:

A mixture of dry salammoniac and an excess of lime (either quick- or slaked-lime) is heated in a medium-sized flask, the top of the mixture being covered with small lumps of quicklime in order to dry the ammonia as it escapes. The gas is led off through a delivery tube which projects into an inverted gas-jar supported on a bee-hive shelf, as shown in the sketch.

(ii) The odour and action on red litmus paper should first be noted.

(iii) The gas may be poured upwards in the manner described for hydrogen (Experiment XIX).

(iv) A lighted taper is extinguished by the gas, but at the moment of extinction a yellow flame of burning ammonia can be seen playing round the taper.

(v) If a jar be inverted in water, the latter rises very quickly, showing the great solubility of the gas.

(vi) Jars containing ammonia and hydrogen chloride respectively are placed in contact: torrents of white fumes of ammonium chloride are produced.

(vii) If the gas be led over heated copper oxide, copper, water, and nitrogen are formed.

Ammonia is a little more than half as light as air (three-fifths). It burns readily in oxygen, forming water and nitrogen, and on account of the fact that it is decomposed into its elements at about 700° and that the liberated hydrogen is a great reducer, it behaves as a reducing agent itself. Thus, with copper oxide: $2NH_3 + 3CuO = 3Cu + 3H_2O + N_2$.

The Ostwald process of producing nitric acid by the oxidation of ammonia was developed during the war. A mixture of air and ammonia (up to 10 per cent.) is passed through heated platinum gauze (which acts as a catalyst), and the oxides of nitrogen produced are recovered as nitric acid by absorption in water, or as nitrate by absorption in lime or other alkali. (1) $4NH_3 + 5O_2 = 6H_2O + 4NO$. (2) $4NO + 2O_2 = 4NO_2$. (3) $4NO_2 + 2H_2O + O_2 = 4HNO_3$.

Ammonia, it should be remembered, is the most soluble of all gases; at 0° 1 litre of water dissolves 1,300 litres, at 15° 802 litres. The solution has the same smell and alkaline reaction as the gas, but there is much evidence to show that the gas and the water unite to form a compound—ammonium hydroxide, NH_4OH—which, however, is decom-

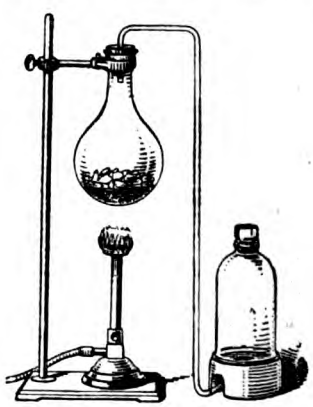


Fig. 28.—The laboratory method of preparing ammonia.

posed when the solution is heated. $NH_3 + H_2O \rightleftarrows NH_4OH$. A ready way of procuring ammonia gas is to heat such a solution.

The strongest solution has a spec. grav. of 0·880, and is usually known as "880 ammonia."

Ammonia readily unites with all acids, forming the so-called ammonium compounds. Thus ammonium chloride is made by "neutralising" ammonia with hydrochloric acid, and ammonium nitrate by the interaction of ammonia and nitric acid. It may be noted that the composition and properties of these compounds bear a strong resemblance to the corresponding compounds of sodium and potassium, and hence it is inferred that they contain a metallic substance called "ammonium."

E. H. T.

LIGHT.—VI

16 (*continued*). **Lenses: General Behaviour.**—The position of an image formed by a lens can be found by using the law of refraction, as explained in Lesson IV. But a simpler method is the following:

Let O be an object placed on the axis of a lens; let C be the optical centre and F the principal focus

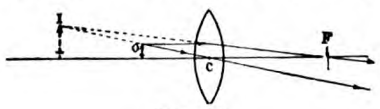


Fig. 50.

of the lens. From O, draw a ray through C; draw a second ray parallel to the axis, which after refraction will pass through F. The point where these two rays intersect will give the position of the image of O. Fig. 51 shows the case of the convex lens producing a real image; Fig. 50 shows the convex lens producing a virtual image; and Fig. 55 shows the case of the concave lens. It will be observed that, though the lens is drawn thick, it has been assumed to be very thin, which is so practically.

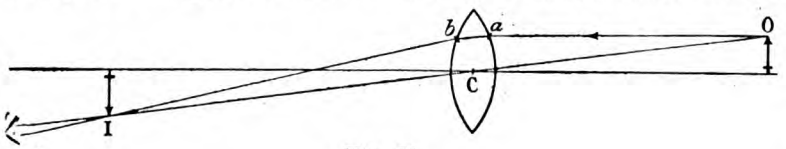


Fig. 51.

The pencil which enters the eye is shown in Figs. 51, 52. From I draw a pencil large enough to fill the pupil of the eye; join the points where the rays of this pencil cut the lens to O. By the pencil sketched, the eye perceives the image of O, real or virtual as the case may be.

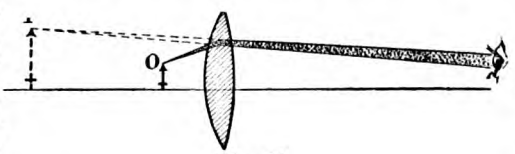


Fig. 52.

The use of the convex lens in a *camera* is probably familiar to every one. It throws an inverted, real image on to the photographic plate. In the *magic lantern*, the picture on the slide is first illuminated by a strong light—the limelight; an image of the illuminated slide is then thrown on to the screen by a convex lens. Of course, the picture in the lantern must be inverted. The image on the screen is enlarged, and consequently much fainter than the object: hence the necessity of the intense source of light.

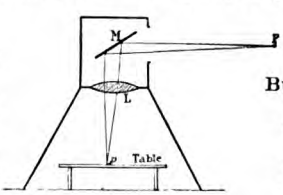


Fig. 53.—Camera Obscura

The *camera obscura*, so familiar at our seaside resorts, combines the action of a mirror and a lens. The plane mirror, M, is placed a little above the tent and inclined at an angle of 45°. The light from distant objects outside is thus reflected vertically downwards. The interposition of the convex lens, L, causes a reduced image to be thrown on to the table below. (Fig. 53.)

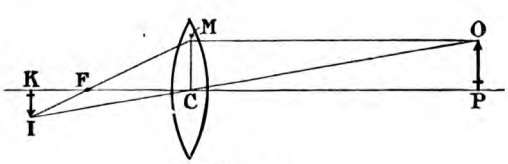


Fig. 54.

17. Calculations on Lenses.—We shall take here the case of the convex lens giving a real image, and shall leave it as an exercise to the student to find the corresponding results when the image is virtual and when a concave lens is employed; no new method is involved in these cases.

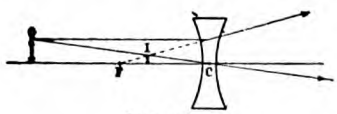


Fig. 55.

Let the object O P be at distance u, the image I K at distance v from C; and let the focal length F C = f. O M is parallel to the axis and M I consequently passes through F. Since the lens is thin, M C may be regarded without measurable inaccuracy as parallel and equal to O P. (Fig. 54.)

1. The triangles O P C, I K C, are equiangular, and therefore similar.

$$\therefore \frac{IK}{OP} = \frac{KC}{CP} = \frac{v}{u}.$$

Now, I K and O P are the sizes of the image and object respectively.

Hence the fraction $\frac{IK}{OP}$ = the magnifying power of the lens, and we obtain the important result that this $= \frac{v}{u}$.

2. The triangles I K F, M C F are also equiangular and similar.

$$\therefore \frac{KF}{FC} = \frac{IK}{MC} = \frac{IK}{OP} = \frac{v}{u}.$$

But K F = $v - f$, and F C = f

$$\therefore \frac{v-f}{f} = \frac{v}{u}$$

$$\therefore uv - uf = vf$$

$$\therefore uf + vf = uv$$

$$\therefore \text{(dividing by } uvf\text{)}, \quad \frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

3. The magnifying power of a lens may be expressed in other useful forms. In 2, we have shown that

$$\frac{v}{u} = \frac{v-f}{f}.$$

Again, $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{u-f}{uf}$.

$$\therefore v = \frac{uf}{u-f}$$

$$\therefore \frac{v}{u} = \frac{uf}{u(u-f)} = \frac{f}{u-f}$$

These expressions for the magnifying power need

not be remembered, if the results of 1 and 2 are committed to memory.

In the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ it is evident that if u is less than f, $\frac{1}{u}$ will be greater than $\frac{1}{f}$, so that $\frac{1}{v}$, and consequently v itself, will be a negative quantity. This means that it must be measured in an opposite direction to that in which it was measured before; i.e., the image is on the same side of the lens as the object. It is important to be clear about this use of the negative sign. In the case of lenses, it will be simplest to adopt a rather different rule from that adopted for mirrors. We take u as positive always; v and f are to be taken as negative when they are measured backwards towards the object, and positive if they are measured in the direction of the light. In other words, u and v are positive when they are on opposite sides of the lens, but v is negative when they are on the same side. This convention harmonises with that adopted for mirrors in making all distances of virtual images negative, and those of real images positive.

Example 1.—In a concave lens, an object at a distance of 4 inches gives a virtual image 1·5 inches from the same side of the lens. What is its focal length?

In the standard formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, $u = 4$ $v = -1{\cdot}5$.

$$\therefore \frac{1}{4} + \frac{1}{-1{\cdot}5} = \frac{1}{f}$$

$$\therefore \frac{1}{4} - \frac{2}{3} = \frac{1}{f} \text{ or } \frac{1}{f} = \frac{3-8}{12}, \text{ or } f = -\frac{12}{5} = -2{\cdot}4$$

The principal focus will therefore be virtual, and 2·4 inches from the lens.

Example 2.—At what distance from a convex lens of $f = 12$ inches must an object be placed so as to give a virtual image 30 inches away?

Here $v = -30$, $f = 12$.

$$\therefore \frac{1}{u} + \frac{1}{-30} = \frac{1}{12}$$

$$\therefore \frac{1}{u} = \frac{1}{30} + \frac{1}{12} \text{ or } u = \frac{360}{42} = 8{\cdot}6''$$

Example 3.—Prove from the formula that a real image cannot be obtained with a convex lens at a point nearer than its principal focus.

We have $\frac{1}{u} = \frac{1}{f} - \frac{1}{v}$.

Hence, since u must be positive, $\frac{1}{f}$ cannot be less than $\frac{1}{v}$.

That is, f cannot be greater than v,

i.e., the real image cannot be formed nearer than F.

The formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ indicates the method by which the focal length of a lens can be determined experimentally. The student should make several measurements of u with the corresponding measurements of v: the values of f thus obtained will be the more nearly concordant the more accurately the practical measurements have been made.

In order to obtain the distance of the virtual image in the case of a concave lens, a pin should be viewed through the lens, and a second pin placed where the first appears to be. The measurement of v can then be made.

The focal length of the lens can be connected with the size of the lens and with its refractive index. The formula is $\frac{1}{f} = (\mu - 1)\left(\frac{1}{r} - \frac{1}{s}\right)$, where r and s are the radii of the spherical surfaces of the lens. This formula is, however, not easy to establish by simple methods, and is only of importance to the beginner as indicating how the refractive index of the lens might be obtained.

In convex lenses, r will be the radius of the smaller sphere, because f is positive.

18. Combination of Lenses.—If the light which has passed through a lens is made to fall upon another lens before it has formed its image, it behaves towards the second lens as if the image had been formed. Thus, suppose two convex lenses whose focal lengths are f_1 and f_2 are placed so close together that their distance apart is negligible, it is easy to calculate the focal length of the combination. For, let u be the distance of the object. The image formed by the first lens would be at distance v given by the equation

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f_1}$$

The light falling on the second lens would appear to come from an object at a distance $-v$ from it, and form its image at w, where

$$-\frac{1}{v} + \frac{1}{w} = \frac{1}{f_2}$$

Adding these two equations, we have

$$\frac{1}{u} + \frac{1}{w} = \frac{1'}{f_1} + \frac{1}{f_2}$$

But $\frac{1}{u} + \frac{1}{w} = \frac{1}{F}$ where F = focal length of the combination.

Hence $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

$$\therefore F = \frac{f_1 f_2}{f_1 + f_2}.$$

If the two lenses are x cm. apart, then v in the second equation must be replaced by $v - x$, for the image formed by the first lens would be at that distance from the second lens.

Example.—Find the focal length of a combination of two convex lenses of focal length 8 cm. and 12 cm. respectively, when placed 3 cm. apart.

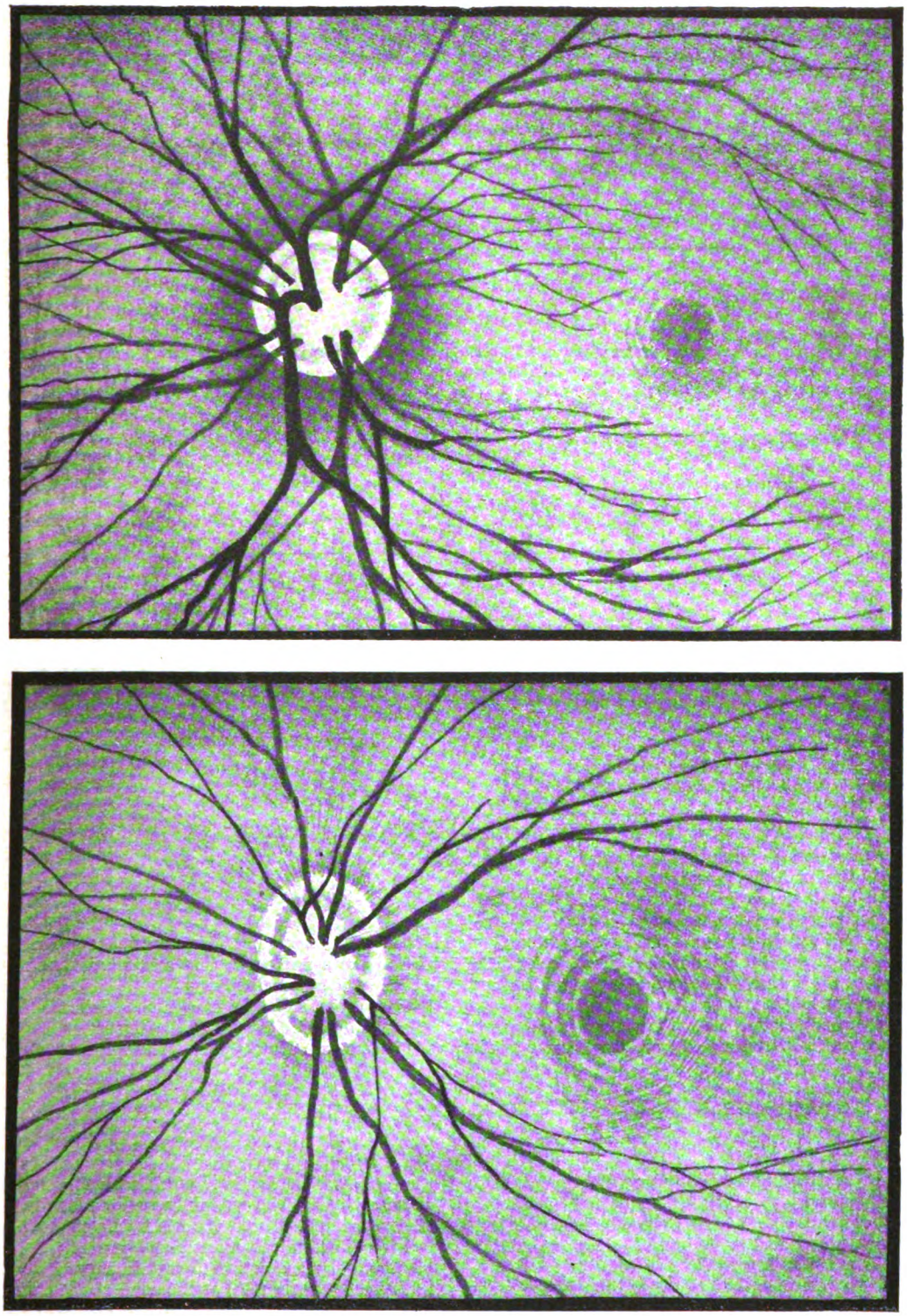
Imagine an object at any distance, say 20 cm. from the first lens.

Then, $\frac{1}{20} + \frac{1}{v} = \frac{1}{8}$, whence $v = \frac{40}{3}$ cm. $= 13\frac{1}{3}$ cm.

Hence the light falls on the second lens as if it were $13\frac{1}{3} - 3 = 10\frac{1}{3}$ cm. from it.

$$\therefore -\frac{1}{10\frac{1}{3}} + \frac{1}{w} = \frac{1}{12}$$

or $w = \frac{124}{22\frac{1}{3}} = \frac{372}{67}$ cm.



MAN AND MONKEY

A striking comparison between the nerve systems of the human eye *(top)* and the eye of a chimpanzee *(bottom)*

$$\therefore \frac{1}{20} + \frac{67}{372} = \frac{1}{F}$$

$$\therefore F = \frac{20 \times 372}{1712} = 4{\cdot}35 \text{ cm.}$$

Observe carefully why we have to take v as negative in the above reasoning. In the second equation it corresponds to u, and is measured in the opposite direction. This convention as to signs should be mastered carefully. We give another example in which this convention has to be watched.

Example. — Find the position and nature of an image formed by two lenses, one convex ($f_1 = 10$) and the other concave ($f_2 = 8$), placed at a distance of 2 cm. apart, the object being 12 cm. from the convex lens.

Considering the convex lens, we have $\frac{1}{12} + \frac{1}{v} = \frac{1}{10}$ or $v = 60$.

If the concave lens were not present, a real image would be formed at 60 cm. from the convex lens; i.e., the light falls on the concave lens, as though it were coming from a point $60 - 2 = 58$ cm. from it.

Hence $\frac{1}{58} + \frac{1}{w} = -\frac{1}{8}$

or $\frac{1}{w} = -\frac{1}{8} - \frac{1}{58} = -\frac{66}{8 \times 58}$; or $w = -\frac{232}{33}$

$= -7$ cm.

That is, a virtual image would be formed 7 cm. behind the concave lens, or 5 cm. behind the convex.

Various optical instruments depend upon the suitable combination of lenses for their action. In both the telescope and the microscope we have essentially two lenses: one, called the *object-glass*, to form the image; and the other, called the *eye-piece*, by which the image is magnified and through which it is viewed.

In the *microscope*, the object-glass is a convex lens of short focus which forms a real image of the object in the microscope-tube. The eye-piece is then arranged so that this image falls within its focal distance; a magnified virtual image (I) is thus formed, which will be inverted because the original real image was inverted. (Fig. 56.)

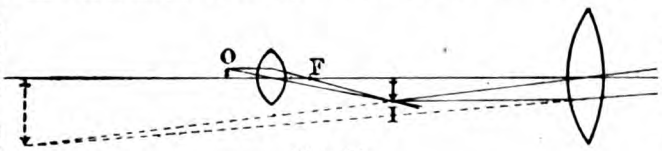


Fig. 55.

In the astronomical *telescope*, our object is to collect as much light as possible from a distant body; hence we have as object-glass a large lens of long focus. This casts a real image in the telescope tube, which is made to fall, as in the microscope, within the focal length of the eye-piece. The result is a magnified, virtual, inverted image of the object observed. (Fig. 58.)

Galileo's telescope differs from this in having a concave lens for the eye-piece. There is no magnification here; but the image is again inverted and virtual. (Fig. 59.) When it is necessary to use the telescope in cases where it is important to have the image erect—as in an opera-glass, which is really a form of Galileo's telescope — an arrangement of convex lenses is made to bring about the inversion of the image before it is viewed by the eye-piece (Fig. 57.) The two lenses, A and B, are placed between the object-glass and the eye-piece, in such a way that the image I given by the object-glass falls at the principal focus of A. Thus the rays from any point emerge parallel from A, and they are brought to a focus again, at I′, as shown in Fig. 57. I′ is then viewed by the eye-piece.

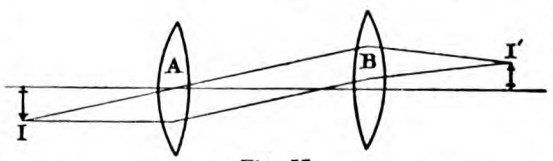


Fig. 57.

19. The Eye.—The eye is an optical instrument whose essential portions are the crystalline lens and the sensitive surface, or *retina*; and in order that an object may be seen as such by the eye, a real image of it must fall on the retina.

Externally the eye has a thick opaque covering, called the *sclerotic* coat, the "white" of the eye; this bulges and becomes transparent in front of the eyeball, forming the *cornea*. This convex surface acts partially as a mirror, so that a small virtual image is seen in it quite plainly.

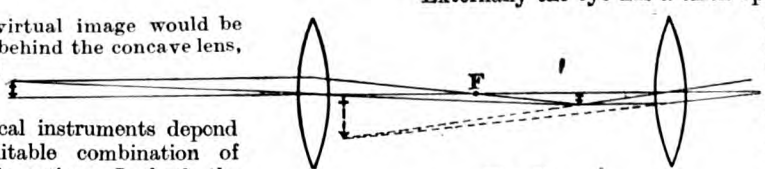


Fig. 58.

Within the sclerotic is a more delicate layer called the *choroid* coat. In the front of the eye this is continued into the *iris*, the coloured ring of the eye, which is perforated centrally by the circular *pupil*. The convex crystalline lens is kept in position just behind the iris by ligaments; the front one, called the *suspensory ligament* (*s.l.*), can be relaxed by the action of certain muscles, called the *ciliary muscles* (*cil.*) at the edge of the choroid. The retina is a delicate membrane, covering about two-thirds of the eye, within the choroid. Between the cornea and the lens is a watery fluid called the *aqueous humour*; the *vitreous humour* between the retina and the lens is slightly more refractive.

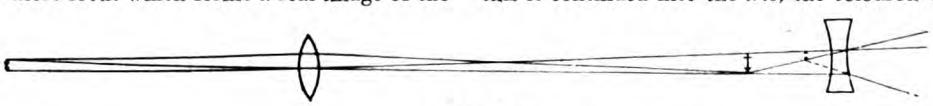


Fig. 59.

The eye is joined to the orbit by various muscles by means of which it may be moved so as to direct its axis towards the object which is being viewed; and this is necessary because vision is most distinct at that portion of the retina nearest the axis of the eye, and known as the *yellow spot*.

The eye is connected to the brain by the *optic nerve*, which appears as a prominent stalk at the back of the eye, situated a little obliquely towards the inner corner. The optic nerve breaks through the sclerotic and the choroid, and its nerve-fibres spread out over the retina. These nerve-fibres themselves are not sensitive to light; hence the spot where the optic nerve enters the eye is called the *blind spot*.

The fluids of the eye, as well as the lens, of course play a part in forming the image on the

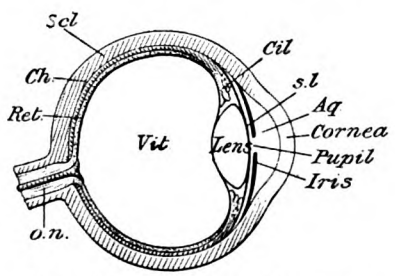


Fig. 61.—The Eye and its parts

retina; but the lens is the more important refractive element, and we may confine ourselves to that. Now it is evident that, if the lens were as rigid as a glass lens is, we should never be able to see objects except when they were at a certain fixed distance, inasmuch as $\frac{1}{u} + \frac{1}{v}$ is constant, and v is in this case unchangeable. But we know that

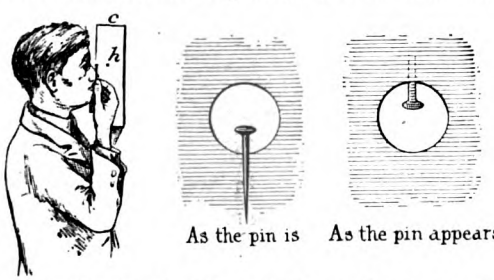


Fig. 62.—Proving that the image formed on the retina is inverted

the eye can "accommodate" itself to objects at different distances; and the power to do this resides in the lens, which is elastic in nature.

When the eye is at rest, the lens is adapted to the distinct vision of a distant object. If, then, it is desired to view exactly a near object, the ciliary muscles contract and, pulling the choroid forward, loosen the pressure of the suspensory ligament on the front surface of the lens. The result of this is that the front surface of the lens bulges forward, and the lens thus becomes more convex than it was before. It can then bring to focus on the retina the light from a nearer object, which would otherwise pass beyond it. (Fig. 60.)

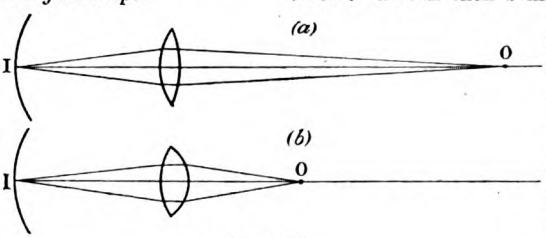


Fig. 60.

Thus a definite effort has to be made to see near objects, which of course accounts for the fatigue felt after prolonged attention to close work. The power of accommodation is by no means unlimited: with a normal eye it is reached at a distance of 2·5 to 3 inches, within which no distinct image of an object can be obtained. We shall deal briefly with abnormal eyes in our next lesson.

The image cast on the retina will necessarily be inverted, but nevertheless, objects are seen in their true position; this change is accomplished in the brain, and is no concern of physics. That the image is inverted may be shown by the following simple experiment:—

Take a piece of cardboard and make a good-sized pinhole in it. Hold up the card about three inches or so from the eye in a good light; and then hold a pin so that the pin-head is in the straight line from the hole to the eye. The light from the pinhole will then throw a shadow of the pin on to the eye; and this shadow will appear to come from the opposite side of the hole to that in which the pin is being held. (Fig. 62.) Now the shadow is certainly the right way up, and the interposition of a lens does not alter this. [Try it.] But the shadow *seems* inverted and is not; hence the image of the pin itself must be inverted.

The iris of the eye contains some muscles which are arranged radially and by their contraction enlarge the aperture of the pupil. Now, if the pupil is small, only a small portion of the lens will receive the light, and a more exact image will result. Hence in a bright light the pupil is very small. But in a faint light the pupil has to be enlarged in order to let in sufficient light to affect the retina. This enlargement of the pupil, brought about by the muscles of the iris, can easily be followed by observing your own eye on passing out of a light room into a gloomy one. And the inconvenience of entering a brightly lighted room is not overcome until the iris has reduced the size of the pupil.

As we have seen, the light diverging from a point is not converged *exactly* to another point by a convex lens, but is spread out over a caustic curve. This is known as the *spherical aberration* of the lens, and the function of the iris is to reduce the spherical aberration to a minimum. The same function is performed by the "stop" in a camera.

The student will see, if he turns to page 394, Vol. II., how a caustic curve is formed. Rays far removed from the axis do not converge to a point, the light distributes itself in a curve. E. W. E.

ELECTRICITY AND MAGNETISM.—VI

Magnetic Field of an Electric Current.—As we are about to commence the study of Current Electricity, the intimate relation between this form of electricity and magnetism may receive some attention at this stage.

The various means by which an electric current may be produced will form the subject of the next lesson, but for the present we must accept the fact that we have a current of electricity at our disposal without inquiring into its mode of production.

A "dry cell" which can be obtained at an electrician's, or any shop where electric bells are for sale, will supply the current. The cost of such a cell may be about two shillings. If the student should possess a small accumulator, a better current will be obtained, though that from a dry cell will be sufficient. In addition to the source of current, four or five yards of moderately thick wire covered with rubber and cotton to prevent the escape of electricity will be necessary. Wire of this kind is said to be *insulated*, and it can be obtained at the same place as the dry cell and will be found to be quite inexpensive.

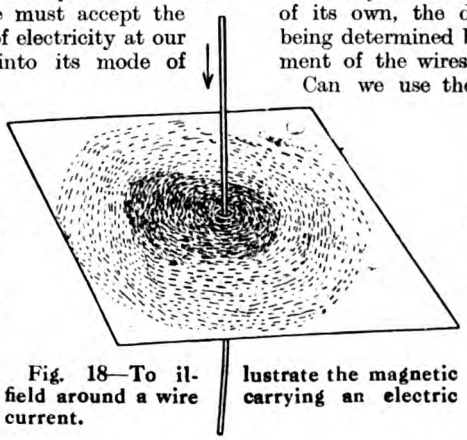


Fig. 18—To illustrate the magnetic field around a wire carrying an electric current.

The cell is provided with a screw at the top, and a wire attached to the side. These are called the terminals of the cell. A current of electricity will

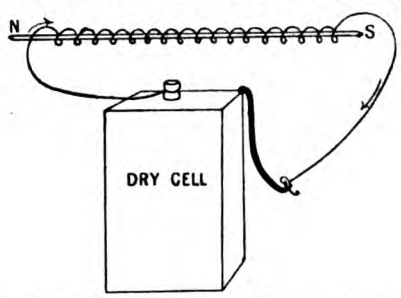


Fig. 19.—How to make a bar magnet by means of an electric current.

flow from the screw to the wire attached to the cell when they are connected by some metallic substance such as some of the insulated wire. When the wire is connected to the terminals of the cell, the cotton and rubber must be removed from the ends, or no current will flow.

Let us investigate some of the properties of a wire along which a current is flowing.

Experiment 18.—*To find out if an electric current has a magnetic field.*

In a piece of cardboard, pierce a hole sufficiently large to allow the insulated wire to pass through it. Take about one yard of the wire, pass it through the cardboard, and fix up to the terminals of the cell. Arrange the wire so that it is vertical where it passes through the cardboard, which should be held horizontally. Gently sprinkle iron filings on the card and notice that they arrange themselves in concentric rings around the wire (Fig. 18).

There is a magnetic field around the wire as long as the current is flowing, and the lines of force are in the form of circles in planes at right angles to the wire.

Hence any electric current has a magnetic field of its own, the direction of the lines of force being determined by the direction and arrangement of the wires carrying the current.

Can we use the field of an electric current for producing induced magnetism?

Experiment 19.—*To induce magnetism by means of an electric current.*

Wind the yard of insulated wire used in the last experiment around an unmagnetised piece of steel (say a knitting needle) from one end to the other, and always winding in the same direction.

Before attaching the ends of the wire to the terminals of the cell, test the steel to be quite sure that it is not magnetic. Fasten the wire to the cell and the steel becomes magnetic under the influence of the current (Fig. 19).

The polarity of the new magnet will depend upon which direction the current flows along the wire.

The current flows *from* the screw at the centre of the top of the dry cell, and *if we imagine that we are swimming with the current and facing the magnetised needle, its north pole will be on our left.* This relation is true generally, and is known as Ampère's rule, after the French scientist Ampère.

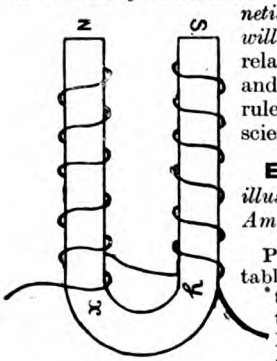


Fig. 20.—A simple electro-magnet.

Experiment 20.—*To illustrate another phase of Ampère's rule.*

Place a compass on a table and allow the needle to become stationary in the magnetic meridian. Fasten a wire to the dry cell so that a current flows. Bring a straight part of the wire down slowly over the compass and in such a way that the wire itself is in the magnetic meridian. Imagine that you are swimming with the current and looking down upon the compass, and its north pole will be deflected towards your left.

Electro-Magnets.—As we ascertained above, in Experiment 19, the steel became a permanent magnet, but if a piece of iron had been used in its place, we should have had a magnet that remained magnetic only as long as the electric current was flowing. Such temporary electro-magnets, as they

are called, are extremely important in practical applications. They are much more powerful than any permanent steel magnets, and their magnetism suddenly appears and disappears at convenient moments.

Experiment 21.—*To make an electro-magnet.*

Obtain a bar of soft iron (cylindrical in shape, if possible) about seven or eight inches long, and having any convenient diameter, say half an inch. Such a bar may be obtained from a blacksmith or ironmonger at a trifling cost. Have it bent into the form of the letter **U**.

Near the position x commence winding the four yards of insulated wire, being careful to wind in the direction shown in Fig. 20, and to leave two inches of wire for purposes of connection to a source of current. Continue winding until you reach the position N, then working backwards to position x, wind another layer of wire on top of the first, always winding in the same direction.

Now, if the bar were straight we could have wound continuously along its entire length, but as it is bent

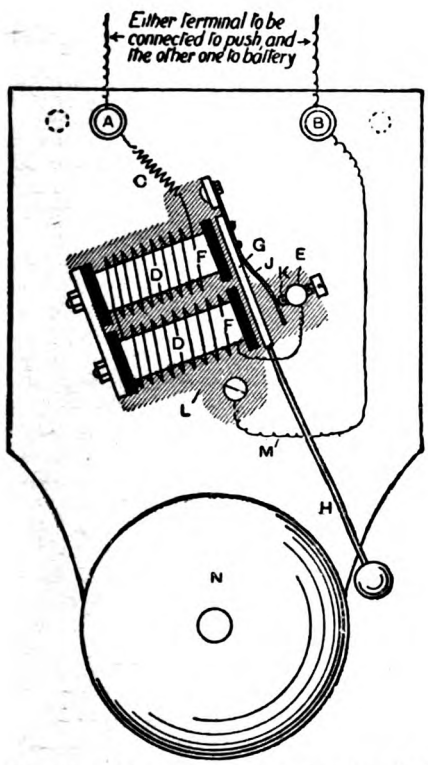


Fig. 21.—Diagram showing the electrical system of the trembling bell.

we must so wind that the coils of wire are wound in the same direction as if we had proceeded along a straight bar. Hence we cross the wire over to position y on the other side, and wind in the opposite direction, as indicated by the figure. Wind down to the position S, and then back again to y.

Cut off any surplus wire after leaving two inches for connection.

On sending a current through the wire, the iron exhibits strong magnetic properties, and if a powerful current is used a weight of several pounds may be lifted easily.

If the current is sent along the wire from the end near the position x, then N will be the North pole of the magnet according to Ampère's rule.

Directly the current ceases to flow, owing to a disconnection, the iron loses all perceptible magnetism.

Electro-magnets are of various sizes according

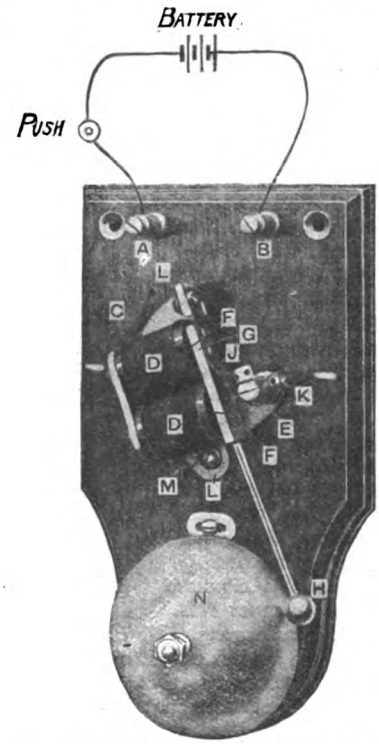


Fig. 22.—Electric Trembling Bell, cf. Fig 21.

to the nature of the machinery in which they form parts, the large ones being in dynamos and the smaller ones being in electric bells.

The Electric Bell will serve as an illustration of the very useful nature of electro-magnets, and in studying this and other practical applications we must bear in mind the fundamental principle of electro-magnets: they are magnetic to an appreciable degree *only while the current flows.*

By referring to Figs. 21 and 22 it will be noted that the essential parts of an electric bell are: an electro-magnet D D (the poles of the magnet are situated at F F—hidden from view by the armature G), a piece of iron—i.e.: the armature G—attached to which is a hammer H for striking the gong N. Also attached to the armature is a spring J, sufficiently strong to overcome the inertia of G, but not strong enough to resist the magnetism of D D.

Contact is made and broken between the tip of the screw K and a speck of platinum attached to the spring J.

A and B are terminal screws for attaching wires from a source of electricity.

Let us trace the path of an electric current entering the apparatus at A.

It flows along the wire C, then around the coils of the electro-magnet, through an insulated wire (not in view) to the insulated pillar of E, through spring J, metal frame L, wire M (which runs at the back of the board), to terminal B, and thence back to the battery.

The whole path of the current, from the dry cell and back to it again, is called the *Circuit*, and if the current is to flow there must be no break (i.e., disconnection) in the circuit. There must be a complete metallic path for the current to follow from the cell, and back to it again.

When the current flows, D has magnetic properties, hence the piece of iron, or armature, is pulled on to the poles opposite. This leaves a space between it and the screw K.

The path of the current is broken, so that the current ceases to flow, whereupon D D loses its magnetic properties, and G springs back to its original position, against K. The current again flows and the action of G is repeated. Consequently the current is allowed to flow and then broken several times per second, and every time G moves across to the poles of the electro-magnet D D the hammer hits the gong. We must notice the importance of K, G, and D D. The apparatus is there constructed in such a way that the electric current is constantly being broken and then renewed. Such an arrangement is called a *Make and Break.*

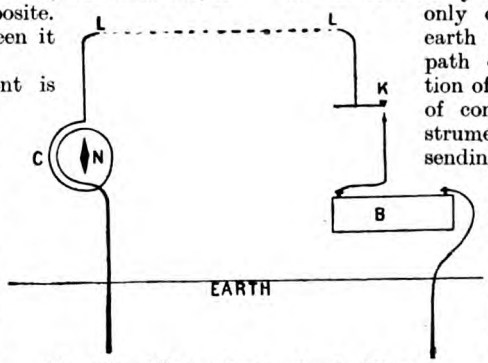


Fig. 23.—Illustrating a simple Electric Telegraph.

It makes no difference in the working of the bell if the current enters by the screw B instead of A, though the current will then flow in the opposite direction. When an electric bell is fitted up a permanent break in the circuit is always inserted, and this break is usually termed the " bell-push." On pushing the " button " of such a bell-push two pieces of metal come into contact, the circuit is then complete, the current flows, and the bell rings.

The Electric Telegraph.—The experiments we have already made suffice to show that a wire carrying an electric current causes a compass needle to be deflected. We may now consider briefly, and without detail, the mode of using this property of a current in sending messages from one place to another in a very short time. If a coil of wire is turned around a magnetic needle which is free to move in a vertical plane, and a current of electricity is sent through the coil, the poles of the needle will move to the right or left according to the direction of the current.

In the diagram N represents such a needle surrounded by a coil of wire C. At the distant transmitting end of the line, or place from which a message is being sent, the key, or tapping instrument, is represented by K. B is a collection of electric cells fitted up so as to give a good current, and LL represents a long wire (called the line) joining the transmitting and receiving stations.

When the operator presses down the key, the path for the current is completed, and as the electricity flows through the coil around the needle at the receiving station, it causes the needle to move either to the right or left according to the direction of the current, a matter that is under the control of the operator. The movements of the upper half of the needle are noted by the receiver. A code in which so many movements to the right, to the left, or to the right and left, means a certain letter of the alphabet, enables a person at the receiving end to construct the message. Of course each station has its transmitting and receiving apparatus.

It will be seen by reference to the diagram that only one wire is necessary, the earth acting the part of the return path of the current. This function of the earth, and many details of construction in telegraphic instruments such as a combined sending and receiving apparatus, cannot be explained until we have dealt more fully with the study of current electricity, but the brief description given will serve the purpose of showing another practical application of the close relation between magnetism and electricity.

A very important form of telephone consists of an apparatus which works in a manner similar to that of an electric bell. This apparatus, technically known as a " buzzer," is used in place of a magnetic needle as a receiver. By means of a collection of signs known as the Morse Code, the various letters of the alphabet are represented by short buzzing noises or " dots " and by longer buzzing noises or " dashes." By the right combination of " dots and dashes " any letter of the alphabet and punctuation marks may be signalled and thus messages sent to a distant station. The chief signs of the Morse Code are as follows :—

A · —	N — ·
B — · · ·	O — — —
C — · — ·	P · — — ·
D — · ·	Q — — · —
E ·	R · — ·
F · · — ·	S · · ·
G — — ·	T —
H · · · ·	U · · —
I · ·	V · · · —
J · — — —	W · — —
K — · —	X — · · —
L · — · ·	Y — · — —
M — —	Z — — · ·
Full Stop · · · · · ·	Interrogation · · — — · ·
Comma · — — — — ·	

L. M. P.

Continued from page 33.

LANGUAGES:

***Contributors*:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A.[Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).**

LATIN.—XVIII

LATIN adverbs may be classified in two ways, (a) according to their formation, into those formed from prominent roots, those from adjectives, and others of different origin ; and (b) according to their meaning, into three classes—(1) adverbs of place, (2) adverbs of time, and (3) adverbs of manner.

Adverbs

Adverbs of place express the notions implied by the phrases " where," " whence," " whither " or " towards what," and " by what way."

Adverbs expressing the notion of " where " or rest in a place comprise the following :—

circum, *around.*
cōrum, *face to face.*
extrā, *outside.*
fōris, *out of doors, abroad.*
infrā, *below.*
intŭs, *within.*
juxtā, *hard by.*
passim, *here and there.*
pĕregrē, *away from home.*
praestō, *at hand.*
prŏcul, *far away.*
prŏpĕ, *near.*
subtĕr, *beneath.*
sŭpĕr, sŭperně, suprā } *above.*

Those expressing the notion of " whence " or motion from a place comprise :—

cœlĭtŭs, *from the sky.*
fundĭtŭs, *from the foundation, completely.*
ēmĭnŭs, (ex mănŭs) } *from a distance* opposed to commĭnŭs, *hand to hand.*
rādīcĭtŭs, stirpĭtŭs } *from the root, root and branch.*

Those expressing the notion of " whither " or motion towards a place comprise :—

adversŭs or adversum } *against, opposite to.*
dĕorsŭs (-um), *downwards.*
dextrorsŭs (-um), *to the right.*
introrsŭs (-um), *inwards.*
trorsŭs (-um), *forward, straight on.*
retrorsŭs (-um), *backwards.*

Those expressing the idea of " by what way " comprise **illīc, illūc, quā**, and other adverbs of pronominal origin included in the following table :—

Demonstrative.	*Indefinite.*
hĭc, *here.*	ŭbīquĕ, *everywhere.*
istīc, *there* (near you).	ŭbĭvīs, ŭbĭlĭbĕt } *where you will, anywhere.*
illīc, *there* (yonder).	
ĭbī, *there.*	uspĭam } *somewhere, anywhere.*
ĭbĭdem, *in the same place.*	ălīcŭbī }
	usquam (with neg.), *anywhere.*
	nusquam, *nowhere.*
	ălĭbī, *elsewhere.*
	utrōbīquĕ, *in both places.*
	utrimquĕ, *on both sides.*

Relative or Interrogative.	
ŭbī,	*where* or *where ?*
ŭbĭcunquĕ,	*wherever.*

Demonstrative.	*Indefinite.*
hinc, *hence.*	undĭquĕ, *from every side.*
istinc, *thence* (from near you).	undĕcunquĕ, *from whatever side.*
illinc, *thence* (from yonder).	utrimquĕ (*or* utrinquĕ), *from both sides.*
indĕ, *thence.*	ălĭundĕ, *from elsewhere.*
indĭdem, *from the same place.*	ălĭcundĕ, *from somewhere or other.*

Relative or Interrogative.	
undĕ,	*whence*, or *whence ?*

Demonstrative.	*Indefinite.*
hūc, *hither.*	quōvīs } *whither you will.*
istūc, *thither* (to near you).	quōlĭbĕt }
illūc, *thither* (to yonder place).	utrōquĕ, *to both places.*
ĕŏ, *thither.*	utrōvīs, *to which place* (of two) *you will.*
ĕōdem, *to the same place.*	ălĭō, *to another place.*
	ălĭquō, *to some place.*
	quōquam (with neg.), *to any place.*

Relative or Interrogative.	
quō,	*whither* or *whither ?*
quōnam,	*whither ?*
quōcunquĕ, quōquō }	*whithersoever.*

Demonstrative.	*Indefinite.*
horsum, *hitherwards.*	quōquōversum (-ŭs), *in any* or *every direction.*
istorsum, *thitherwards* (towards where you are).	ălĭorsum (-ŭs), *towards some other place.*
illorsum, *thitherwards* (towards yonder place).	ălĭquorsum (-ŭs), *towards some place.*

Relative or Interrogative.	
quorsum (-ŭs), *towards what* or *towards, what?*	
Demonstrative.	*Indefinite.*
hāc, *by this way.*	ălīquā, *by some way.*
istāc, *by that way* (near you).	quāvīs / quālĭbĕt, *by which way you will.*
illāc, *by that way* (yonder).	utrācumquĕ (-cunquĕ), *by which way (or two) you will.*
ĕā, *by that way.*	utrāquĕ
ĕādem, *by the same way.*	
Relative or Interrogative.	
quā, *by which way* or *by which way?*	
quācumquĕ (-cunquĕ), *by whichever way.*	

Temporal Adverbs

Temporal adverbs or adverbs of time express the notions of "when," "how long," and "how often." A number of them may be classified, independently of these three categories, on the lines of the preceding tables. Thus **tunc** or **tum**, *then*, **ilĭcĕt** or **illĭcō**, *forthwith*, **hŏdiē**, *to-day*, and **interĕā**, *meanwhile*, may be classed as demonstratives; **cum** or **quum**, *when*, **quandōquĕ** or **quandōcumquĕ** (**-cunquĕ**), *whenever*, and **ŭbī**, *when*, are relatives; **quandō**, *when*, is an interrogative; and **umquam** (**unquam**), *ever*, **numquam** (**nunquam**), *never*, **nonnumquam** (**-nunquam**), **interdum**, **ălĭquando** or **quandōquĕ**, *sometimes*, and **ălĭās**, *at another time*, are indefinite. The correlatives **quamdiū** *how long?* or *as long as*, **tamdiū**, *so long*, **quŏtiēs**, *how often?* or *as often as* and **tŏtiēs**, *so often*, should also be noted, as well as the indefinite adverbs related to these, **ălĭquamdiū**, *for a while*, and **ălĭquŏtiēs**, *several times*. By observing these relations between words the student will find his path eased considerably, both in interpreting Latin sentences and in acquiring a vocabulary for his own use.

Among the more common temporal adjectives expressing the notion of "when" are :—

antĕ / antĕā, *before.*	mŏdŏ, *just now.*
crās, *to-morrow.*	mox, *soon.*
dēmum, *at length.*	nunc, *now.*
extemplō, *forthwith.*	nuper, *lately.*
hĕrī or hĕrĕ, *yesterday.*	olim, *at that time.*
hŏdiē, *to-day.*	prōtĭnŭs, *forthwith.*
iam, *now, already.*	quandō, *when?*
iamdiū, *long since.*	quandōquĕ, *sometime.*
iamdūdum / iamprīdem, *now and for a long while.*	quondam, *of old, formerly.*
intĕrĕā or intĕrim, *meanwhile.*	sempĕr, *always.*
	tandem, *at length.*
	tum, tunc, *then.*

Those expressing the notion "how often" include :—

ădhūc, *till now, hitherto.*	quamdiū, *how long? as long as.*
ălĭquamdiū, *for a while.*	sempĕr, *continually.*
diū, *long.*	tamdiū, *so long* (as).
părumpĕr, *for a little while.*	

Those expressing the idea "how often" include :—

aliquŏtiēs, *at various times.*	quŏtiēs, *how often? as often as.*
cotidiē (quotidiē), *daily.*	rārō, *seldom.*
crēbrō, *often.*	saepĕ, *often,*
interdum, *sometimes.*	sĕmĕl, bis, tĕr, etc., *once, twice, thrice,* etc.
ĭtĕrum, *again.*	tŏtiēs, *so often.*
quŏtannīs, *yearly.*	

Modal Adverbs

Modal adverbs or adverbs of manner constitute by far the most numerous of the three classes, comprising as they do the adverbs formed from adjectives. Almost every adjective in Latin has a corresponding verb.

ADVERBS OF MANNER

ălĭtĕr, *otherwise.*	praecīpuē / praesertim, *especially.*
ceu, *just as.*	prŏpĕ, *nearly.*
clam, *secretly.*	quāsī, *as if.*
ĕātĕnus, *in so far.*	quātĕnŭs, *how far? as far as.*
fortĕ, *by chance.*	quōmŏdŏ, *in what manner?*
frustrā, *in vain.*	saltem, *at least.*
hactĕnŭs, *thus far.*	sĕcŭs, *otherwise.*
ĭtă, *thus, so.*	sīc, *so, thus.*
ĭtem, *likewise.*	sīmĭlĭtĕr, *in like manner.*
mŏdŏ, *only.*	tamquam (tanquam), *as, as if.*
omnīnŏ, *altogether.*	ultrō, *further.*
paenĕ, *almost.*	usquĕ, *quite.*
pălam, *openly.*	ut, *as, how.*
partim, *partly.*	vĕlŭt, *or* vĕlŭtī, *as for instance.*
perinde (ăc, atquĕ, *or* ŭt), *just* or *exactly as.*	vix, *scarcely, hardly.*
pŏtĭŭs (superl. pŏtissĭmum), *rather.*	

Adverbs of degree are not always clearly distinguishable from many of these, but at any rate include :—

ădĕō, *to such an extent.*	nĭmĭs or nĭmĭum, *too much.*
admŏdum, *exceedingly.*	părum, *too little.*
atque (ăc), *equally as much as.*	quam, *how? as, than.*
ĭtă, *so.*	sătĭs, *enough.*
măgis, *more, rather.*	tam, *so.*
mĭnŭs, *less.*	valdĕ, *very, greatly.*

Adverbs of interrogation include :—

cūr or quārē, *why?*	quŏtiēs, *how often?*
-nĕ (enclitic), *is it that?*	utrum . . .an, *whether . . . or.*
nonnĕ, *is it not that?*	utrum . . . annōn (*or* necnĕ), *whether . . or not.*
num, *is it that?*	
quīn, *why not?*	

The enclitic **-nĕ**, and the particles **nonnĕ** and **num** are used to introduce questions, **nonnĕ** anticipates an affirmative and **num** a negative answer. Enclitics like **-quĕ** and **-nĕ** throw back their accent on to the words to which they are attached, as in **mĕmĭnistĭnĕ**, not **mĕmĭnistĭ-nĕ**. Words ending in **s** often drop this before **-nĕ**, as **sătĭn**, for **sătisnĕ**.

Adverbs of negation include :—

haud, nōn } *not.*
mĭnĭmē, *by no means.*
nē, *not* (in prohibitions).
nē . . . quĭdem, *not even.*

Adverbs of affirmation, emphasis, transition, etc., include :—

certē, sānē, vērō, *certainly.*
ĕcastŏr, ĕdĕpŏl, mĕhercle, *by Castor, Pollux, or Hercules, in verily.*
ĕquĭdem, quĭdem, *indeed.*
ergō, idcircō, ĭdĕō, ĭgĭtŭr, *therefore, accordingly.*
ĭtem, *likewise.*
praetĕrĕā, *besides.*
scīlicĕt, *of course, to wit.*

Adverbs formed from Adjectives

There are two classes of adjectives, (1) those declined in the masculine and neuter like nouns of the second declension and in the feminine like nouns of the first declension, and (2) those declined in all genders like nouns of the third declension.

(*a*) Adverbs are formed from adjectives of the first class by adding **ē** to the base, thus :—

Adjective	*Base*	*Adverb*
dignŭs, *worthy.*	dign-	dignē, *worthily.*
mīsĕr, *wretched.*	mīsĕr-	mīsĕrē, *wretchedly.*
văfĕr, *sly.*	vafr-	vafrē, *slyly.*

(*b*) From some adjectives of this class adverbs are formed by adding **ō** to the base, thus :—

falsŭs, false.	fals-	falsō, *falsely.*
mĕrĭtŭs, *deserving*	**mĕr**.t-	mĕrĭtō, *deservedly.*
tūtŭs, *safe.*	tūt-	tūtō, *safely.*

(*c*) From adjectives of the second class adverbs are formed by adding **ĭtĕr** to the base if the adjective ends in **-is**, **-er**, or **x**, or **-ĕr** if the adjective ends in **-ns** (base, **-nt**), thus :—

ācĕr, *sharp.*	ācr-	ācrĭtĕr, *sharply.*
fĕrox, *wild.*	fĕrōc-	fĕrōcĭtĕr, *wildly.*
fortĭs, *brave.*	fort-	fortĭtĕr, *bravely.*
ămans, *loving.*	ămant-	ămantĕr, *lovingly.*

(*d*) The neuter singular of many adjectives is used as an adverb, as :—

dulcĭs, *sweet.*	dulcĕ (or dulcĭtĕr), *sweetly.*
făcĭlis, *easy.*	făcĭlĕ, *easily.*
multŭs, *much.*	multum, *much.*
perfĭdŭs, *treacherous.*	perfĭdum, *treacherously.*
plērīquĕ (plur.), *the greater number.*	plĕrumquĕ, *for the most part, very frequently.*

Exercise 17

Translate into English :—

1. Aliquando bonus dormitat Homerus. 2. Nunquam minus solus quam quum solus. 3. Sat cito, si sat bene. 4. Res multum et saepe quaesita. 5. Majores nostri Carthaginem et Numantiam funditus sustulerunt. 6. Ferme acerrima proximorum odia sunt.

Translate into Latin :—

1. Handsome enough, if good enough. 2. To have prayed well is to have studied well. 3. I number only shining hours. 4. To know truly is to know through causes. 5. Who proves too much proves nothing. 6. Beware what you say, when and to whom.

Key to Exercise 16

1. Where as soon as they arrived. 2. Ancient speeches have ceased to be read by large numbers. 3. People rush into the forum from every side. 4. The name of Perseus has never ceased to be celebrated. 5. A Mercury is not made out of any odd bit of wood. 6. Out of nothing nothing comes.

1. Bis peccare in bello non licet. 2. Interdum stultus bene loquitur. 3. Mendacem memorem esse oportet. 4. Decet verecundum esse adolescentem. 5. Mihi dolet quum ego vapulo. 6. Volenti non fit iniuria.

E. A. B.

FRENCH.—XVIII

Reflexive Verb se flatter (*continued*)

Imperative Mood

flatte-toi, *flatter thyself.*
qu'il se flatte, *let him flatter himself.*
flattons nous, *let us flatter ourselves.*
flattez-vous, *flatter yourselves.*
qu'ils se flattent, *let them flatter themselves.*

Subjunctive Mood

PRESENT	PERFECT
que je me flatte, *that I may flatter myself.*	que je me sois flatté, *that I may have flattered myself.*
que tu te flattes	que tu te sois flatté
qu'il se flatte	qu'il se soit flatté
que nous nous flattions	que nous nous soyons flattés
que vous vous flattiez	que vous vous soyez flattés
qu'ils se flattent	qu'ils se soient flattés

IMPERFECT	PLUPERFECT
que je me flattasse, *that I might flatter myself.*	que je me fusse flatté, *that I might have flattered myself.*
que tu te flattasses	que tu te fusses flatté
qu'il se flattât	qu'il se fût flatté
que nous nous flattassions	que nous nous fussions flattés
que vous vous flattassiez	que vous vous fussiez flattés
qu'ils se flattassent	qu'ils se fussent flattés

Infinitive Mood

PRESENT	PAST INDEFINITE
se flatter.	s'être flatté.
PRESENT PARTICIPLE	PERFECT PARTICIPLE
se flattant.	s'étant flatté.

Uses of Reflexive Verbs.—The reflexive form of the verb is often used in French in the same sense as the passive in English, thus—

Cela se voit tous les jours.	*That is seen every day.*
Cette marchandise se vend facilement.	*That merchandise is easily sold.*
Cela se fait ainsi.	*That is how it is done.*

The verb **se porter,** *to carry oneself*, is used idiomatically for *to do* or *to be* as regards health, thus—

Comment vous portez-vous ?	*How do you do ?*
Je me porte très bien, merci.	*I am very well, thank you.*

The following also have idiomatic meanings :—

s'asseoir, *to sit down.*	marcher, *to walk, to ride, to go.*
se promener, *to walk, to ride* (for pleasure, etc.).	

These three verbs are conjugated in the present indicative as follows :—

je me porte, *I am* or *do.*	je me promène, *I take a walk* or *ride.*
tu te portes.	tu te promènes,
il se porte.	il se promène.
nous nous portons.	nous nous promenons.
vous vous portez.	vous vous promenez,
ils se portent.	ils se promènent.

je m'assieds, *I sit down* or *am sitting down.*
tu t'assieds.
il s'assied.
nous nous asseyons.
vous vous asseyez.
ils s'asseient.

Examples :—

Votre frère s'assied.	*Your brother sits down.*
Je me promène tous les jours.	*I take a walk every day.*
Je me promène à cheval.	*I take a ride.*
Marchez-vous beaucoup tous les jours ?	*Do you walk much every day ?*

The following active verbs are most commonly used in the reflexive form with idiomatic meanings :—

ennuyer, *to weary, to bore, to annoy.*	amuser, *to amuse.*
s'ennuyer, *to be dull, bored,* or *disgusted.*	s'amuser, *to amuse oneself, to take pleasure,* or *spend one's time* (in).
tromper, *to deceive.*	
se tromper, *to be mistaken.*	

Examples :—

Il trompe tout le monde.	*He deceives everybody.*
On se trompe bien souvent.	*One is very often mistaken.*
Cet homme ennuie ses auditeurs.	*That man wearies his hearers.*
Vous nous ennuyez par vos demandes.	*You weary us with your questions.*
Nous nous ennuyons ici.	*We are tired of being here.*
Vous ennuyez-vous à la campagne ?	*Are you tired of being in the country ?*
Nous nous amusons à la campagne.	*We enjoy ourselves in the country.*
Vous vous amusez à des bagatelles.	*You spend your time in trifles.*

The reflexive verb **se passer** is used in the sense *to do without :* **se servir,** in the sense *to make use of ;*

Examples :—

Pouvez-vous vous passer de ce livre ?	*Can you do without this book ?*
Je ne puis m'en passer,	*I cannot do without it.*
Je me sers de votre canif,	*I make use of your penknife.*
Je ne m'en sers pas,	*I do not use it.*
Je m'en sers, je m'en passe,	*I use it, I do without it.*

Note that the pronoun used as indirect object of a reflexive verb, if it stands for a person, follows the verb, thus—

Je puis me passer de lui,	*I can do without him.*
Je m'addresse à vous et à elle,	*I apply to you and to her.*

The reflexives **s'approcher,** to approach, **s'éloigner,** *to recede from, to leave*, take the preposition **de** before a noun, and also before a pronoun except when this takes the form **en ;**

Examples :—

Ne voulez-vous pas vous approcher du feu ?	*Will you not draw near the fire ?*
Il ne s'en approche pas.	*He does not come near it.*
Pourquoi s'éloignent-ils de la fenêtre ?	*Why do they go away from the window ?*
Ils s'en éloignent parce qu'il y fait trop froid.	*They go away from it because it is too cold there.*

Some reflexive verbs take a direct object denoting a part of the body, the reflexive pronoun being in this case the indirect object, thus—

Je me chauffe les mains et les pieds.	*I warm my hands and feet.*

Similarly **se rappeler,** *to recall, to remember*, takes a direct object denoting the thing remembered, thus—

vous rappelez-vous ces demoiselles ?	*Do you remember those young ladies ?*
je ne me les rappelle pas.	*I do not remember them.*

Before an infinitive **se rappeler** has the preposition **de,** as in—

Nous ne nous rappelons pas d'en avoir été privé.	*We do not remember having been deprived of it.*

Se souvenir, *to remember,* takes the preposition **de** before substantives as well as before the infinitive, thus—

Vous souvenez-vous de cette affaire ?	*Do you remember that affair ?*
Je ne m'en souviens pas,	*I don't remember it.*
Je me souviens de lui avoir écrit,	*I remember having written to him.*

VOCABULARY

s'adresser, *to apply.*
appliquer, *to apply.*
l'arbre (m.), *the tree.*
le banquier, *the banker.*
bientôt, *soon.*
briller, *to sparkle, shine.*
le cerveau, *the brain.*
charmant, *charming.*
le crâne, *the skull.*
de bonne heure, *early.*
douter, *to doubt, suspect.*
ébaucher, *to sketch.*
efforcer, *to force.*
l'esprit (m.), *mind, wit.*
le faisceau, *the cluster* (of columns, etc.).
fatiguer, *to tire out.*
flotter, *to float.*
le fouet, *the whip.*
huile (f.), *oil.*
humer, *to inhale.*
humide, *moist.*
jouir, *to enjoy.*
jusque-là, *to that point, hitherto.*
le lever, *the getting up.*
le lever du soleil, *sunrise.*
magnifique, *magnificent.*
la manière, *the manner, way.*
mériter, *to deserve.*
obliger, *to oblige.*
s'occuper, *to busy oneself.*
la paroisse, *the parish.*
la part, *the share, part, portion.*
patiner, *to skate.*
le peintre, *the painter.*
le point du jour, *daybreak.*
prendre, *to take, catch.*
profond, *profound, deep.*
la puissance, *power.*
raisonner, *to think out, argue.*
rapprocher, *to approach.*
rassasier, *to sate, satiate, satisfy.*
le râteau, *rake.*
sentir, *to fret, understand.*
la terreur, *terror.*

Exercise 33

1. Il se rapprocha d'elle avec terreur. 2. Je me mis la tête dans les mains. 3. Quand le cerveau me tournait dans le crâne, je m'efforçai de raisonner la situation horrible dans laquelle j'étais pris. 4. L'esprit se contente d'y briller en mots charmants ou profonds, mais bientôt dits. 5. Elles se sentirent supérieures à tout ce qu'elles avaient été dans leur plus beaux soirs. 6. Elles y jouirent d'une puissance inconnue dont jusque-là elles ne s'étaient jamais doutées. 7. Il se montre d'une manière plus distincte. 8. Les arbres s'élèvent à la manière de faisceaux. 9. Ils le méritent bien. 10. À quoi vous appliquez-vous ? 11. Je m'occupe de mes affaires. 12. Comment se porte monsieur votre père ? 13. Je m'assieds quand je suis fatigué. 14. Ne nous asseyons pas, il est trop tard. 15. Combien ce drap se vend-il le mètre ? 16. Cette dame ne s'appelle-t-elle pas L. ? 17. Fait-il beau temps aujourd'hui ? 18. Il fait un temps magnifique ; n'allez-vous pas vous promener ? 19. N'allez-vous pas à cheval tous les matins ? 20. Je me couche de bonne heure. 21. Je me lève au point du jour.

Exercise 34

1. I do not know his name. 2. No, madam, her name is M. 3. He is much better. 4. Cannot you walk ? I am too tired to walk. 5. I go for a walk every morning. 6. How do you go ? Sometimes on foot and sometimes in a carriage. 7. To whom do you apply when you want money ? 8. I apply to my banker. 9. Will you not sit down ? 10. We are very much obliged to you. 11. Do you cut your fingers ? 12. I often cut my fingers when I mend my pen. 13. Do you remember your brother's misfortunes ? 14. I remember his misfortunes. 15. I do not remember it at all. 16. We go to bed every day at sunset. 17. We rise earlier than you—at sunrise. 18. Does not the carpenter cut his hand ? 19. What are you busy with ? 20. We are busy with our affairs.

Key to Exercise 29

1. They had never seen her well enough to be able to recognise her. 2. She had always had that pride of very proud beings. 3. Her beauty would have been no obstacle to her entrance into the countess's service. 4. They had not read "The Marriage of Figaro." 5. Your hand must have felt the blow. 6. She had seen rightly. 7. She had shut her eyes. 8. He would have done it at once, had he not had his wife on his arm. 9. I therefore asked her questions. 10. Has their conduct been approved ? 11. It is approved by no one. 12. Is that lady esteemed and approved ? 13. She is neither esteemed nor approved.

Key to Exercise 30

1. Êtes-vous la maîtresse de la maison ? 2. Je la suis. 3. Votre mère est-elle aimée de votre sœur ? 4. Elle est aimée de son frère et de sa sœur. 5. Les Italiens sont-ils aimés des Français ? 6. Vos écoliers ne sont-ils pas blâmés ? 7. Ils sont blâmés quelquefois. 8. Sont-ils souvent punis ? 9. Ils sont rarement punis. 10. Par qui êtes-vous puni quand vous êtes paresseux ? 11. Je ne suis jamais puni. 12. Sa conduite a-t-elle été approuvée ? 13. Elle a été approuvée de tout le monde. 14. Cet auteur est-il estimé ?

Key to Exercise 31

1. Night was quite come. 2. I do not know where they had started from to reach this point. 3. Were you at the ball yesterday evening ? 4. We were not there. 5. Where is your sister gone this morning ? 6. I have not yet been out. 7. She went to see him yesterday. 8. She came at a quarter to eight. 9. Were those young ladies born at Rouen or at Caen ? 10. Is the watchmaker at home ? 11. No, sir, he is gone to his shop. 12. He is already furnished with money. 13. It was made for me ; I was made for it. 14. O Diogenes ! if you saw your disciple wearing the proud mantle of Aristippus, how you would laugh ! 15. Ah ! they little care for the universe. 16. Do you wish me to stop ? 17. Have you found my father ? 18. Has your father been out to-day ? 19. Did your mother arrive to-day or yesterday ? 20. Has not your brother left for England ?

Key to Exercise 32

1. Elles ne sont nées ni à Rouen ni à Caen, elles sont nées à Strasbourg. 2. A-t-il été à Paris cette année ? 3. Oui, madame, il y a été. 4. Y a-t-il acheté des marchandises ? 5. Il y a acheté de bijouterie. 6. Il n'est pas sorti, il est malade. 7. Votre père est-il à la maison ? 8. Non, monsieur, il est sorti. 9. Quand est-il sorti ? 10. Il est arrivé hier à quatre heures du matin. 11. Votre cousin a-t-il été voir son père aujourd'hui ? 12. Il est parti pour Paris. 13. Non, monsieur, il est retourné en Allemagne. 14. Ma sœur a été à l'église ce matin, et elle est allée à l'école il y a une demi-heure. 15. Jusqu'où votre frère est-il allé ? 16. Il est allé jusqu'à Paris. 17. Combien de temps avez-vous demeuré à Londres ? 18. Nous y avons demeuré six ans. 19. Jusqu'où avez-vous été ? 20. Nous avons été jusqu'aux Champs Élysées. E. A. B.

GERMAN.—XV

The dative is primarily the case of the indirect or remoter object with verbs. It is represented in English either by the simple objective or by the objective case governed by a preposition.

Dative with Verbs.—(*a*) Some verbs take in addition to the accusative of the direct object, a remoter object in the dat. These are verbs denoting giving, taking, removing, telling, commanding, showing, promising, permitting, and so on. Er gibt mir ein Buch, *he gives me a book;* Sie ſchrieb ihrer Mutter einen Brief, *she wrote a letter to her mother.*

(*b*) Many verbs with the inseparable prefixes ent, er, ver, and with the separable prefixes an, auf, ab, bei, vor, nach, zu. Er vermachte ihr ſein ganzes Vermögen, *he bequeathed to her his whole fortune.*

(*c*) A number of verbs take a reflexive pronoun in the dat. Ich habe mir dadurch geſchadet, *I injured myself by that;* ich habe mir die Sache angeſehen, *I looked at the thing* (for myself).

When these transitive verbs are used in the passive voice and the acc. becomes the nom., the dat. is retained: Das Packet iſt Ihrem Sohn gebracht worden, *the parcel was brought to your son.*

(*d*) Many verbs take a dat. without taking any acc. Such are verbs denoting belonging, being due to, happening, seeming. Das gehört mir, *that belongs to me;* dieſes ſchien ihm ſonderbar, *this seemed curious to him.*

(*e*) A good many verbs with the inseparable prefixes ge, be, er, ent: ſie begegneten mir, *they met me;* er entſagte ſeinem Glück, *he renounced his happiness.*

(*f*) A considerably greater number of verbs compounded with the separable prefixes ab, an, auf, aus, bei, ein, entgegen, nach, unter, vor, wider, zu. The above prefixes, many of which we mentioned just now in connection with transitive verbs, are prepositions which can govern the dat. (Note that **ein** has the meaning *in*); alle ſtimmten mir bei, *all agreed with me.* Er ſah ihr nach, *he looked after her.*

(*g*) A few impersonal verbs, of which the commonest are: es graut mir, *I am horrified* or *I shudder;* es ſchwindelt ihr, *she is giddy;* es bangt ihm, *he is afraid.*

(*h*) Some verbs used with nouns, adverbs and adjectives, such as es tut mir leid, *I am sorry;* es macht mir Kummer, *it grieves me.*

The Dative with Adjectives.—(*a*) This is similar to its use with verbs. Adjectives which take the dat. usually denote nearness, remoteness, likeness, unlikeness, advantage, disadvantage, and so on: Ihre Lippen gleich den Roſen, *her lips like* (to) *roses;* dem Weinen nah, *near to tears* (weeping); die Umſtände ſind mir günſtig, *the circumstances are favourable to me.*

(*b*) With adjectives and adverbs the verbs werden and ſein used impersonally in the sense of *to feel* or *begin to feel* take the dat.: mir wird bange, *I begin to feel afraid;* mir iſt wohl, *I feel well* or *comfortable.*

(*c*) Adjectives formed from verbs by means of the suffixes bar and lich, where these suffixes mean *possible*, govern a dat. of the person for whom it is possible: das iſt mir begreiflich, *I can understand that* or *that is comprehensible to me;* das war ihm undenkbar, *that was unthinkable for him.*

(*d*) Nearly all adjectives modified by **zu**, *too*, and genug, *enough*, take a dat.: das Haus iſt ihm zu groß, *the house is too big for him;* es iſt ihr aber groß genug, *it is, however, big enough for her.*

The Dative of Interest is used for the person on whose behalf a thing is done: er legte ihm die Zeitung auf den Tiſch, *he put the newspaper on the table for him;* machen Sie mir bitte die Tür auf, *please open the door for me.*

In **elliptical phrases** of an exclamatory kind the dat. is often used: weh den Armen, *woe to the poor.*

The student should note that *to* after verbs of motion can never be translated by the simple dat., but must be rendered by either **zu** when followed by a person or **nach** when followed by the name of a place: ſie kommen zu mir, *they come to me;* wir reiſen nach Berlin, *we are travelling to Berlin.*

The Accusative is primarily the case of the object of an action expressed by a verb.

(*a*) Most verbs which are transitive in English take a noun or pronoun in the acc. as their direct object in German: wir lieben unſeren Vater, *we love our father.* Some verbs which in English are intransitive are transitive in German: Ihr Bruder will mich ſprechen, *her brother wants to speak to me.*

(*b*) Some intransitive verbs take a cognate acc., that is a noun expressing an idea akin to that of the verb: ſie ſpielten Spiele zuſammen, *they played games together.*

(*c*) A few intransitive verbs take an acc. of the personal pronoun: er hat ſich heiſer geſchrien, *he has screamed himself hoarse.*

(*d*) Some impersonal verbs take an acc. of the person affected: es dünkt mich, *it seems to me;* mich hungert, durſtet, friert, *I am, hungry, thirsty, cold.*

(*e*) A few transitive verbs take a double acc. These are verbs like lehren, *to teach;* heißen and nennen, *to call* (name); fragen, *to ask;* ſchimpfen and ſchelten, *to call* (using an opprobrious epithet); er lehrt mich manches, *he teaches me many a thing;* Sie fragte mich vieles, *she asked me many things.*

Accusative with Adjectives.—A few adjectives when used predicatively, after ſein and werden may take an accusative. These adjectives are nearly always such as normally take a gen.: ich bin den Kerl los geworden, *I got rid of the fellow.*

Acc. with Prepositions.—For a list of prepositions which take the acc. *see* Vol. II., p. 284.

Acc. used Absolutely. — The acc. is sometimes used with a present or past participle in an absolute construction: er ſtand, den Kopf geſenkt, bewegungslos am Fenſter, *he stood motionless at the window with bowed head.*

Acc. of Nouns used in an Adverbial Sense.—(*a*) To express duration of time: wir wohnten ein ganzes Jahr dort, *we lived there a whole year.*

(*b*) To express point of time: ich werde dieſen Vormittag noch kommen, *I shall come this morning* (forenoon).

(*c*) The day of the month is always indicated by the acc.: den dritten März, *the third of March.*

(*d*) To express space travelled over: er lief die Straße entlang, *he ran down the street.*

(*e*) To express extent, weight, measure: dieſes koſtet einen Taler, *this costs one dollar;* die Kiſte wog einen Zentner, *the chest weighed a hundredweight.*

The impersonal verb es gibt, *there is, there are,* is always followed by the acc.: es gibt keinen Troſt für ſolche Leiden, *there is no comfort for such sufferings.*

Note that an acc. is used with an infinitive after the verbs laſſen, ſehen, hören, machen and lehren: er läßt ihn gehen, *he lets him go;* er macht mich lachen, *he makes me laugh;* er lehrt mich tanzen, *he teaches me to dance.*

Idiomatic uses of doch, *although.*—Er hat ſein beſtes getan und es iſt ihm doch nicht gelungen, *he did his best and, nevertheless, he has not succeeded.* Nicht doch, *by no means.* Spät kommt ihr, doch ihr kommt, *you come late, but still you do come.* Ich habe es doch oft genug geſagt, *I surely have said it often enough.* Sie kommen doch? *Surely they are coming?* Einmal muß er es doch tun, *he must at all events do it once.* Wie wenn es doch der Fall wäre? *How if it were the case after all?* Ich werde es doch tun, *I shall do it for all that.* Geben Sie mir doch das Buch, *do give me the book.* Sie haben ſich doch nicht wehe getan? *You have not hurt yourself I hope?* Wenn doch die Sonne ſchiene, *if only the sun would shine.* Es war mir doch als ob ich Tritte hörte, *I really thought* (felt as if) *I heard footsteps.* It is also used in answer to a negative question. War er nicht dort? Doch. Was he not there? Yes, indeed (he was).

VOCABULARY

Kreuz, s.n.2, *cross.*
ſeit, *since.*
Zone, w.f., *zone.*
Schönheit, w.f., *beauty.*
genugſam, *sufficiently.*
Maß, s.n.2, *measure.*
neu, *new.*
entfalten, w., *to reveal.*
Gefühl, s.n.2, *feeling.*
Annäherung, w.f., *approach.*
beſonders, *especially.*
übergehen, s., *to pass* (over).
Stern, s.m.2, *star.*
zuletzt, *at last.*
Kindheit, w.f., *childhood.*
Reiſende, w.m., *traveller.*
unermeßlich, *immeasurable.*
Vaterland, s.n.3, *fatherland.*
Gruppirung, w.f., *grouping.*
Nebelſtern, s.m.2, *nebulous star.*
Milchſtraße, *Milky-way.*
Raum, s.m.2, *space.*
Schwärze, w.f., *blackness.*
eigentümlich, *peculiar.*
Schauſpiel, s.n.2, *spectacle.*
ſelbſt, *even.*
Bewegung, w.f., *motion.*
Wiſſenſchaft, w.f., *science.*
betrachten, w., *to contemplate.*
majeſtätiſch, *majestic.*
bewundern, w., *to admire.*
Botaniker, s.m.1, *botanist.*
Vegetation, w.f., *vegetation.*
Kenntniß, s.f.2, *knowledge.*
eintreten, s.2*a*, *to enter.*
ſüdlich, *southern.*
vorrücken, w., *to advance.*
Sternbild, s.n.3, *constellation.*
bekannt, *familiar.*
wenn, *when.*
Aequator, s.m., *equator.*
Hemiſphäre, w.f., *hemisphere.*
allmählich, *gradually.*
nieder, *low.*
verſchwinden, s.1*a*, *to disappear.*
erinnern, w. *to remind.*
lebhaft, *vivid.*
Entfernung, w.f., *distance.*
Anblick, s.m.2, *view, sight.*
zerſtreut, *scattered.*
Glanz, s.m.2, *brilliance.*
wetteifern, w., *to rival, compete.*
außerordentlich, *extraordinary.*
auszeichnen, w., *to distinguish.*
Phyſiognomie, w.f., *appearance.*
ſetzen, w., *to set.*
Einbildungskraft, *power of imagination.*
Unterricht, s.m.2, *instruction.*
Himmelsgewölbe, s.n.1, *dome of heaven.*
Landſchaft, w.f., *landscape.*
Ausſicht, w.f., *view.*
nötig haben, *to have need.*
bloß, *mere, bare.*

erlangen, w., *to acquire.*
vertraut, *familiar.*
Europa, *Europe.*
phosphoreſcierend, *phosphoreſcent.*
aufſteigen, s.3*b*, *to rise.*
Süden, s.m.1, *South.*
heiß, *hot.*
erkennen, w., *to recognise.*
Aſtronomie, f., *astronomy.*
Himmelſcharte, w.f., *chart* (of the sky).
fühlen, w., *to feel.*
ungeheuer, *gigantic.*
Horizont, s.m.2, *horizon.*

Exercise 37

Das Kreuz des Südens.

Seit wir in die heiße Zone eingetreten[1] waren, konnten wir jede Nacht die Schönheit des ſüdlichen Himmels nicht genugſam bewundern, welcher[2] in dem Maße, als wir nach Süden vorrückten, unſern Augen[3] neue Sternbilder entfaltete. Man hat ein wunderbar[4] bekanntes Gefühl, wenn[5] man bei Annäherung gegen den Aequator, und beſonders wenn man von der einen Hemiſphäre in die andere übergeht, allmählich die Sterne niederer werden und zuletzt verſchwinden ſieht[5], welche man von ſeiner erſten Kindheit an kennt. Nichts erinnert einen Reiſenden lebhafter an die unermeßliche Entfernung ſeines Vaterlandes, als der Anblick eines neuen Himmels. Die Gruppierung der großen Sterne, einige zerſtreute Nebelſterne, welche an Glanz mit der Milchſtraße wetteifern, und Räume, welche durch eine außerordentliche Schwärze ausgezeichnet ſind, geben dem ſüdlichen Himmel eine eigentümliche Phyſiognomie. Dieſes Schauſpiel ſetzt ſelbſt die Einbildungskraft derjenigen in Bewegung[6], welche ohne Unterricht in den höhern Wiſſenſchaften, das Himmelsgewölbe gern betrachten, wie man eine ſchöne Landſchaft oder eine majeſtätiſche Ausſicht bewundert. Man hat nicht nötig Botaniker zu ſein, um die heiße Zone bei dem bloßen Anblicke zu erkennen[7]; ohne Kenntniß in der Aſtronomie erlangt zu haben, ohne mit den Himmelſcharten von Flamſteed und La Caille vertraut zu ſein, fühlt man, daß man nicht in Europa iſt, wenn man das ungeheuere Sternbild des Schiffs oder die phosphoreſcierenden Wolken Magellans am Horizont aufſteigen ſieht.

A. von Humboldt.

NOTES:

(1) Eingetreten waren, eintreten being a verb of motion is conjugated with **ſein**. (2) welcher, mas. sing., refers to Himmel. (3) Augen, dat. of indirect object. (4) wunderbar, adverb. (5) wenn, the finite verb of this adverbial clause is ſieht at the end of the sentence. (6) Bewegung, in Bewegung ſetzen, is to set in motion, here used figuratively in the sense of to excite or stimulate. (7) erkennen, infinitive depending on **um**.

VOCABULARY

letter, Brief, s.m.2.
Dr., Doktor, m.
way, Weg, s.m.2.
to, nach.
of, von.
next, nächſt.
moment, Augenblick, s.m.2.
tell, ſagen, w.
to be aware of, ſich einer (gen.) Sache bewußt ſein.
expression, Ausdruck, s.m.2.
as, da.
extend, weitergehen, s. (sep.)
endeavour, verſuchen, w.
die, Sterben, s.1*c*.
attend, begleiten, w.
family vault, Familiengruft, s.f.2.
illness, Krankheit, w.f.
death, Tod, s.m.
tranquil, friedlich.
pain, Schmerz, w.m.
situation, Zuſtand, s.m.2.
feel, fühlen, w.
observation, Bemerkung, w.f.
peace, Friede, s.m.
truth, Wahrheit, w.f.
only, nur.
thank, danken, w., gov. dat.
part, Teil, s.m.2.
to be happy, ſich freuen, w.
east, Oſten, s.m.
yours very truly, Ihr ſehr ergebener.
to, an.
regard, Hochachtung, w.f.
on business, geſchäftlich.
at least, wenigſtens.
remain, bleiben, s.3*b*.
at, in.
absence, Abweſenheit, w.f.
I am, ich verbleibe.

Exercise 38

Letter from Lord Byron to Dr. Pigot.

Newport Pagnell, August 2, 1811.

My dear Doctor,

My poor mother died yesterday, and I am on my[1] way from town to attend her to the family vault. I heard one day of her illness, and the next of her death. Thank God[2], her last moments were tranquil. I am told[3] she[4] was in little pain[5], and not aware[6] of her situation. I now feel the truth of Mr. Gray's observation, "That we can only have one mother." Peace be with her.

I have[7] to thank you for your expressions[8] of regard; and as[9] in six weeks I shall be in Lancashire on business, I may[10] extend to Chester, at least I shall endeavour[11]. I[12] shall remain at Newstead the greater part of this month, where I shall be happy to hear from you after my two years'[13] absence in the East.

I am, dear Pigot, yours very truly,

Byron.

NOTES:

(1) *My*, say *the*. (2) Thank God: Gott ſei Dank, *thanks be to God*. (3) I am told, one tells me. (4) she; supply the conjunction *that* before *she*. (5) was . . . pain, had little (wenig) pains. (6) aware; the verb *was* must be inserted here, as in the first part of the sentence *was* is rendered by *had*. (7) have to, must, müſſen. (8) Expressions, use in the singular. (9) as . . . business, order: *as I in six weeks on business in L. shall be*. (10) may extend; say *shall perhaps* (vielleicht) *extend*. (11) endeavour; supply the object *it*. (12) I . . . month; place the adverbial phrase of time before that of place. (13) years'; say *absence of* (von) *two years*.

Key to Exercise 35

The water murmured, the water swelled, a fisherman sat by it, looked to his rod quietly, cool right into the depths of his heart. And as he sits and as he listens, the flood is cleft asunder; out from the troubled water a watery maiden (woman) rises rustling.

She sang to him, she spoke to him: Why, do you entice my brood up into the deadly heat with man's wit and man's cunning? Ah, if you knew how cosy the little fish are at the bottom, you would come down as you are and would become whole for the first time.

Does not the dear sun, does not the moon refresh itself in the sea? Do they not return with their appearance doubly beautified by the breath of the waves? Does not the deep heaven entice you, the blue transfigured by the waters? Does not your own face entice you hither into the eternal waves (dew)?

The water murmured, the water swelled, wetted his bare foot; his heart grew as full of longing as at the greeting of his love. She spoke to him, she sang to him; then he was lost; she half drew him and he half sank down, and was never more seen.

Key to Exercise 36

Der Zauberer und der Schneider.

Ein Zauberer und ein Schneider unterhielten ſich zufällig; „Ach," ruft der Schneider aus, „was für ein unglückliches, armes Weſen bin ich! Wenn es den Leuten einfallen ſollte ohne Kleider zu leben, bin ich verloren, ich habe kein andres Handwerk an das ich mich halten kann."

„In der Tat Freund ich bedauere Sie aufrichtig," antwortet der Zauberer, „aber Gott ſei Dank ſteht es mit mir nicht ganz ſo ſchlecht! wenn ein Kunſtſtück verſagen ſollte, habe ich noch hundert andere Kunſtſtücke für ſie. Aber wenn Sie zu irgend einer Zeit an den Bettelſtab gebracht werden ſollten, ſo wenden Sie ſich an mich, und ich werde Ihnen helfen." Eine Hungersnot überzog das Land; der Schneider ernährte ſich mühſam, weil ſeine Kunden nicht ohne Kleider ſein konnten; aber der arme Zauberer mit all ſeinen hundert Kunſtſtücken, konnte Niemand finden der Geld wegzuwerfen hatte; umſonſt verſprach er Feuer zu eſſen, oder Nadeln zu ſpeien; kein einziges Weſen wollte ihm helfen, bis er endlich gezwungen wurde denſelben Schneider anzubetteln deſſen Beruf er früher verachtet hatte.

M. A. L.

RUSSIAN.—VII

The Noun

54. *The Plural of Masculine Nouns.*—The endings of masculine nouns are in the following list:—

Nominative	-ы	-и	-и
Genitive	-овъ	-евъ	-ей
Dative	-амъ	-ямъ	-ямъ

Accusative used instead of Nominative for inanimate objects.

Accusative as Genitive for living beings.

Instrumental	-ами	-ями	-ями
Prepositional	-ахъ	-яхъ	-яхъ

(See Table E for full declensions)

56. Instead of **-ы**, some nouns have the ending **-а** in Nominative Plural. The following come under this category:

Nom. Sing.	*Nom. Plur.*
Áдресъ, *the address.*	Адресá
Бéрегъ, *the shore.*	Берегá
Вéчеръ, *the evening.*	Вечерá
Гóродъ, *the town.*	Городá
Глазъ, *the eye.*	Глазá
Домъ, *the house.*	Домá
Óстровъ, *the island.*	Островá
Вóлосъ, *the hair.*	Волосá
Гóлосъ, *the voice.*	Голосá
Мáстеръ, *the master, foreman.*	Мастерá
Рукáвъ, *the sleeve.*	Рукавá

57. Nouns whose Nominative Singular end in -гъ, -къ, or -хъ, such as врагъ, *an enemy;* рабóтникъ, *a workman;* успѣхъ, *a success,* change the **-ы** to **-и** in the Nominative Plural, and follow for the rest the Table E for the word фабрикáнтъ.

58. Nouns whose Nominative Singular end in -жъ, -чъ, -шъ, and -щъ, such as ножъ, *a knife,* ключъ, *a key,* шалáшъ, *a tent,* плащъ, *a cloak,* have in the Nominative Plural the ending **и**, and in the Genitive **-ей**, while their Dative, Instrumental, and Prepositional remain the same as per Table E for the word фабрикáнтъ.

59. The Nouns ending in Nominative Singular in -áнинъ or -я́нинъ, such as: Англича́нинъ, *an Englishman,* крестья́нинъ, *a peasant,* are declined in the Plural as follows:

Nominative	*Genitive*	*Dative*
Англича́не	Англича́нъ	Англича́намъ
Крестья́не	Крестья́нъ	Крестья́намъ
Accusative	***Instrumental***	***Prepositional***
Англича́нъ	Англича́нами	Объ англича́нахъ
Крестья́нъ	Крестья́нами	О крестья́нахъ

55. *Table E. Full Declension of Masculine Plural.*

Original	Фабрикáнтъ	Казначéй	Покупáтель
Nominative . .	Фабриканты, *the manufacturers*	Казначéи, *the treasurers*	Покупáтели, *the customers.*
Genitive . . .	Фабрикáнтовъ, *of the manufacturers*	Казначéевъ, *of the treasurers*	Покупáтелей, *of the customers.*
Dative	Фабрикáнтамъ, *to the manufacturers*	Казначéямъ, *to the treasurers*	Покупáтелямъ, *to the customers.*
Accusative . . .	Фабрикáнтовъ, *the manufacturers*	Казначéевъ, *the treasurers*	Покупáтелей, *the customers.*
Instrumental . .	Фабрикáнтами, *with the manufacturers*	Казначéями, *with the treasurers*	Покупáтелями, *with the customers.*
Prepositional . .	О фабрикáнтахъ, *about the manufacturers*	О казначéяхъ, *about the treasurers*	О покупáтеляхъ, *about the customers.*

60. The Nouns дру́гъ, *a friend*, мужъ, *a husband*, кня́зь, *a prince, duke*, сы́нъ, *a son*, бра́тъ, *a brother*, are declined in plural as follows :

Nom. Sing.	Дру́гъ	Мужъ	Кня́зь	Сы́нъ	Бра́тъ
Nom. Plur.	Друзья́	Мужья́	Князья́	Сыновья́	Бра́тья
Gen. Plur.	Друзе́й	Мужей	Князе́й	Сынове́й	Бра́тьевъ
Dat. Plur.	Друзья́мъ	Мужья́мъ	Князья́мъ	Сыновья́мъ	Бра́тьямъ
Acc. Plur.	Друзе́й	Мужей	Князе́й	Сынове́й	Бра́тьевъ
Instr. Plur.	Друзья́ми	Мужья́ми	Князья́ми	Сыновья́ми	Бра́тьями
Prepos. Plur.	О друзья́хъ	О мужья́хъ	О князья́хъ	О сыновья́хъ	О бра́тьяхъ

61. The Nouns сосѣ́дъ, *the neighbour*, господи́нъ, *a gentleman*, хозя́инъ, *a principal, owner, master*, челове́къ, *a man*, ребёнокъ, *a child* (and any young animal with name ending in -ёнокъ), are declined as follows :

Nom. Sing.	Сосѣ́дъ	Господи́нъ	Хозя́инъ	Челове́къ	Ребёнокъ
Nom. Plur.	Сосѣ́ди	Господа́	Хозя́ева	Лю́ди	Ребя́та
Gen. Plur.	Сосѣдей	Госпо́дъ	Хозя́евъ	Люде́й	Ребя́тъ
Dat. Plur.	Сосѣдямъ	Господа́мъ	Хозя́евамъ	Лю́дямъ	Ребя́тамъ
Acc. Plur.	Сосѣдей	Госпо́дъ	Хозя́евъ	Люде́й	Ребя́тъ
Instr. Plur.	Сосѣдями	Господа́ми	Хозя́евами	Людьми́	Ребя́тами
Prepos. Plur.	О сосѣдяхъ	О господа́хъ	О хозя́евахъ	О лю́дяхъ	О ребя́тахъ

Note.—With the numerical words пять, *five*, and upwards, the word челове́къ is used in Genitive Plural, unchanged, instead of люде́й.

62. The Nouns зубъ, *a tooth* (in the mouth), листъ, *a sheet* (of paper), *a list, a leaf* (of a book), крюкъ, *a hinge* (of a door), ко́рень, *the root* (of a tree), are declined like Table E, i.e. :

Nom.	*Gen.*	*Dat.*	*Acc.*	*Instr.*	*Prepos.*
Зу́бы	зубо́въ	зуба́мъ	зу́бы	зуба́ми	въ зуба́хъ
Листы́	листо́въ	листа́мъ	листы́	листа́ми	на листа́хъ
Крю́ки	крюко́въ	крю́камъ	крю́ки	крюка́ми	на крю́кахъ
Ко́рни	корне́й	корня́мъ	ко́рни	корня́ми	въ ко́рняхъ

63. The Nouns зубъ, denoting *the tooth* (of a saw, comb, or a wheel), листъ, *the leaf* (of a tree), крюкъ, *hook*, or *crook*, ко́рень, *root* (of a herb, etc.), are declined as follows :

Nom., Зу́бья, ли́стья, крю́чья, коре́нья.
Gen., Зу́бьевъ, ли́стьевъ, крю́чьевъ, коре́ньевъ.
Dat., Зу́бьямъ, ли́стьямъ, крю́чьямъ, коре́ньямъ.
Accus., Зу́бья, ли́стья крю́чья, коре́нья.
Instr., Зубья́ми, листья́ми, крючья́ми, коре́ньями.
Prepos., Въ зу́бьяхъ, о ли́стьяхъ, на крю́чьяхъ, въ коре́ньяхъ.

64. The Nouns стулъ, *a chair*, клинъ, *a wedge*, брусъ, *a joist, whetstone*, ко́лосъ, *an ear* (of corn), are declined like зубъ in Rule 63.

65. The Nouns сукъ, *a bough*, клокъ, *a tuft, lock* (of hair), are declined like крюкъ in Rule 63.

66. The Nouns учи́тель, *a teacher*, ве́ксель, *a bill*, край, *an edge, district, country, province*, have the ending -я in the Nom. Plur.

67. The following Nom. Plurals—хлѣба́, цвѣта́, мѣха́, образа́, denote *corn* (grain), *colours, furs, images* (of saints) respectively.

68. The same nouns being in Nom. Plur.

Nom. Sing.	Сосѣ́дъ	Господи́нъ	Хозя́инъ	Челове́къ	Ребёнокъ
Nom. Plur.	Сосѣ́ди	Господа́	Хозя́ева	Лю́ди	Ребя́та
Gen. Plur.	Сосѣдей	Госпо́дъ	Хозя́евъ	Люде́й	Ребя́тъ
Dat. Plur.	Сосѣдямъ	Господа́мъ	Хозя́евамъ	Лю́дямъ	Ребя́тамъ
Acc. Plur.	Сосѣдей	Госпо́дъ	Хозя́евъ	Люде́й	Ребя́тъ
Instr. Plur.	Сосѣдями	Господа́ми	Хозя́евами	Людьми́	Ребя́тами
Prepos. Plur.	О сосѣдяхъ	О господа́хъ	О хозя́евахъ	О лю́дяхъ	О ребя́тахъ

хлѣбы́, цвѣты́ мѣхи́, and о́бразы, denote *loaves* (of bread), *flowers, bellows*, and *forms* (manners) respectively.

69. The following Nouns have their Gen. Plur. identical with the Nom. Sing. : арши́нъ, *an arshin*, глазъ, *an eye*, солда́тъ, *a soldier*, сапо́гъ, *a boot*, челове́къ, *a man*, разъ, *a time*.

Practice XX

(*a*) Express in Gen. Plur. the following :

Това́ръ, *goods, merchandise.*
Го́родъ, *town.*
По́ѣздъ, *train.*
Кра́й, *district.*
Сара́й, *stable, shed.*
Ге́ній, *genius.*
Глазъ, *eye.*
Цвѣтъ, *flower, colour.*
Конь, m., *horse.*
Хозя́инъ, *master.*
Ребёнокъ, *child.*
Дворяни́нъ, *nobleman.*
Зубъ, *a tooth* (of a comb).
Штемпель, m., *a stamp.*
Челове́къ, *a man.*

(*b*) Change the following to Dat. Plur. :

Глазъ, *the eye.*
Разъ, *a time.*
Челове́къ, *man.*
Англича́нинъ, *an Englishman.*
Солда́тъ, *a soldier.*
Островъ, *an island.*
Сосѣдъ *a neighbour.*
Ножъ, *a knife.*
Господи́нъ, *a gentleman.*
Братъ, *a brother.*
Листъ, *a list.*
Другъ, *a friend.*
Листъ, *a leaf.*
Ко́рень, *a root.*
Ключъ, *a key.*

(*c*) Change the following into Acc. Plur.:

Учи́тель, *a teacher.*	Ребёнокъ, *a child.*
Геро́й, *a hero.*	Братъ, *a brother.*
Крестья́нинъ, *a peasant.*	Домъ, *a house.*
Князь, *a duke.*	А́дресъ, *an address.*
Врагъ, *an enemy.*	Аршѝнъ, *an arshin.*
Мѣхъ, *a fur.*	Сапо́гъ, *a boot.*
Сынъ, *a son.*	Солда́тъ, *a soldier.*
Шала́шъ, *a hut.*	

(*d*) Change the following into Instr. Plur.:

Челове́къ, *a man.*	Хлѣбъ, *bread, corn.*
Го́лосъ, *a voice.*	Край, *district.*
Цвѣтъ, *a flower.*	Ножъ, *a knife.*
Зубъ, *a tooth* (in mouth).	Мужъ, *a husband.*
Плащъ, *a cloak.*	Ве́че́ръ, *an evening.*
Сынъ, *a son.*	Сосѣдъ, *a neighbour.*
Князь, *a duke.*	Хозя́инъ, *a principal.*
Глазъ, *an eye.*	

(*e*) Change the following into Prep. Plur.:

Ребёнокъ, *child.*	Листъ, *leaf* (of a tree).
Господи́нъ, *gentleman.*	Сукъ, *a bough.*
Братъ, *brother.*	Крюкъ, *hinge* (of a door).
Ключъ, *a key.*	Англича́нинъ, *an Englishman.*
Солда́тъ, *a soldier.*	Ве́ксель, *a bill.*
Домъ, *a house.*	Го́лосъ, *a voice.*
Сара́й, *a stable.*	Ножъ, *a knife.*
Глазъ, *an eye.*	

The Verb

70. Conjugation of the Verb **Быть**, *to be.*

PRESENT

Singular	*Plural*
1. Я (есмь), *I am.*	1. Мы (есьмы́), *we are.*
2. Ты (еси́), *thou art.*	2. Вы (есте́), *you are.*
3. Онъ есть, *he is.*	3. Они́ суть, m., *they are.*
3. Она́ есть, *she is.*	3. Онѣ суть, f., *they are.*
3. Оно́ есть, *it is.*	3. Они́ суть, n., *they are.*

71. The present tense of the verb быть is not used in modern Russian, and therefore such expressions as "I am an Englishman" are to be translated Я англича́нинъ.

72. PAST

Singular	*Plural*
1. Я былъ, *I was*, m.	1. Мы бы́ли, *we were*, m.
1. Я была́, *I was*, f.	1. Мы бы́ли, *we were*, f.
1. Я бы́ло, *I was*, n.	1. Мы бы́ли, *we were*, n.
2. Ты былъ, *thou wast*, m.	2. Вы бы́ли, *you were*, m.
2. Ты была́, *thou wast*, f.	2. Вы бы́ли, *you were*, f.
2. Ты бы́ло, *thou wast*, n.	2. Вы бы́ли, *you were*, n.
3. Онъ былъ, *he was.*	3. Они́ бы́ли, *they were*, m.
3. Она́ была́, *she was.*	3. Онѣ бы́ли, *they were*, f.
3. Оно́ бы́ло, *it was.*	3. Они́ бы́ли, *they were*, n.

73. FUTURE

Singular	*Plural*
1. Я бу́ду, *I shall be.*	1. Мы бу́демъ, *we shall be.*
2. Ты бу́дешь, *thou wilt be.*	2. Вы бу́дете, *you will be.*
3. Онъ бу́детъ, *he will be.*	3. Они́ бу́дутъ, *they will be*, m.
3. Она́ бу́детъ, *she will be.*	3. Онѣ бу́дутъ, *they will be*, f.
3. Оно́ бу́детъ, *it will be.*	3. Они́ бу́дутъ, *they will be*, n.

74. Imperative of the Verb **быть**.

Будь, *be thou.*	Пусть они́ бу́дутъ, *let them be*, m.
Бу́дьте, *be you*, pl.	Пусть онѣ бу́дутъ, *let them be*, f.
Пусть онъ бу́детъ, *let him be.*	Пусть они́ бу́дутъ, *let them be*, n.
Пусть она́ бу́детъ, *let her be.*	Бу́демъ, *let us be.*
Пусть оно бу́детъ, *let it be.*	

75. *Conjugation of Verbs.*

Past Tense

As with the Verb быть, all other verbs throw off the ending **-ть** of the Infinitive and assume the ending **-лъ**, **-ла**, **-ло**, for Masculine, Feminine, and Neuter Singular, and **-ли** for all genders and persons in Plural.

Examples

Я покупа́лъ, покупа́ла, покупа́ло, *I bought.*
Ты покупа́лъ, покупа́ла, покупа́ло, *thou boughtst.*
Онъ покупа́лъ, *he bought.*
Она́ покупа́ла, *she bought.*
Оно́ покупа́ло, *it bought.*
Мы покупа́ли, *we bought* (all genders).
Вы покупа́ли, *you bought* (all genders).
Они́ покупа́ли, *they bought*, m.
Онѣ покупа́ли, *they bought*, f.
Они́ покупа́ли, *they bought*, n.

Exercise 11

Translate the following into English:

1. Я англича́нинъ, она́ англича́нка.
2. Люблю́ солда́тъ и ребя́тъ.
3. Англича́не имѣ́ютъ мно́го друзе́й.
4. Мы бы́ли въ Россіи мно́го разъ.
5. Молчи́те, ребя́та.
6. Бу́демъ рабо́тать.
7. Онъ хо́дитъ безъ сапо́гъ.
8. Хозяева́ просма́тривали счёты.
9. Расхо́дъ превыша́лъ дохо́дъ.
10. Аге́нты посыла́ли зака́зы.

Exercise 12

Translate the following into Russian

1. We are Englishmen.
2. We hear voices.
3. They bought many arshins of cloth.
4. Teachers have eyes.
5. The boys spoke the truth.
6. Hush, friends.
7. I met many customers.
8. Chairs stood in the office.
9. Let them work.
10. We knew these (э́тихъ) men.

A. C.

Continued from page 38.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

SOUTH AMERICA.—II

In South America, strictly speaking, there is no "colour question." Whites, half-castes, and pure-blooded Indians are accorded exactly the same privileges in education, profession, and in society, and it is by no means uncommon to find educated men of pure Indian blood occupying very important positions in the state.

The populations of South America have been considerably affected by immigration from Europe. This has been most marked of all in Argentina, where Spaniards, Italians, Poles, Russians, Scandinavians, and in fact representatives of every European nation, have helped to swell the total of the millions of citizens this Republic has received from abroad. Southern Brazil, too, has had the benefit of a very numerous immigration from Europe, and Uruguay has received its share, though, of course, on a smaller scale. Considering its eminently suitable climate, Chile has received comparatively few of the labouring European classes; but the reason for this in the past has been in its remote situation on the Pacific Ocean.

Abundance of Minerals

The products of South America comprise a very wide range, as is not surprising when it is considered that they are derived from every degree of climate, from the bleak and snowy southernmost regions to the tropical lands of the north.

Seeing that it was for its mineral wealth that the continent became famed in the days of its early colonisation, we may as well begin with a survey of these. The great Andes chain, running as it does practically the whole length of South America, is astonishingly rich in minerals. Gold, silver, copper, iron, and manganese abound almost everywhere in the range, but more especially in the mountains of Bolivia, Peru, and Chile. The silver mountain of Potosi, situated in the first of these three republics, contains silver mines which are the most historic in the world.

Manganese is widely distributed throughout the Andes. Tin, on the other hand, is to be met with principally in Bolivia, while the nitrate beds of the Pacific Coast are situated in the north of Chile.

The Atlantic states of South America are less highly mineralised. Brazil, nevertheless, is very famous for its diamonds, and, although they have not yet been exploited, there seems little doubt that the deposits of iron to be met with here are enormous. Brazil, too, contains a certain amount of gold and manganese, which minerals are also to be met with in Uruguay.

Coal and Petroleum

Coal is chiefly met with in Southern Chile—the coalfields of Lota, near Coronel, being the largest in the continent—although lesser quantities of this exist in Peru and Venezuela. Guano, by the way, is to be met with on the coasts of both these latter states, the Venezuelan product being found on a series of islands running parallel with the coast.

Petroleum is met with in Venezuela and the Central Andes, and quicksilver, saltpetre and borax are distributed in a few places in the latter range. A peculiarity of some parts of the Central Brazilian shore is the valuable monazite sand.

In dealing with the vegetable products of South America the field is, of course, considerably wider than that of the minerals. So far, however, the shortage of available labour has played an important part in delaying a fuller development of the great natural riches of the continent.

This has been especially evident in the lumber industry, particularly in the case of the Brazilian forests, and those throughout the Amazon basin, which contain a great number of magnificent cabinet woods. The forests of Southern Chile, on the other hand, are already being exploited to a certain extent, and it is a common spectacle here

to see the timber shot down into the rivers by means of slides as is done in Switzerland and elsewhere. The fine woods of Paraguay, too, have already been brought into requisition, and are now employed to an increasing extent in the manufacture of railway carriages, tramcars, and similar purposes.

The rubber industry, of course, stands apart from that of lumber, and this latter has been exploited to no small extent during the past quarter of a century. The rubber field comprises practically the whole of the Amazon basin, and throughout the great network of streams the other industries have been to a large extent abandoned in favour of rubber collection.

Vegetable Products

The other vegetable products of these tropical lowlands are Brazil nuts, vegetable ivory, plantains, piassava, and many other growths peculiar to warm climates. Bananas are now beginning to be freely cultivated in Central Brazil and in northern Colombia, while sugar-cane is grown to a greater or lesser extent in almost every republic, although by far the largest field of this industry is Brazil.

It is Brazil, too, which produces by far the largest amount of the coffee grown in South America, the great coffee-producing state of that country being São Paulo.

Maize is to be met with in every country. The wheat areas, on the other hand, are comparatively restricted, although magnificent wheat belts are to be met with in the Argentine Republic, Chile, Uruguay, and Southern Brazil. This cereal, as well as barley, is cultivated in the uplands of the tropical and sub-tropical countries; but the areas here are comparatively insignificant.

Although tobacco is produced in many districts throughout the continent, it is most successfully grown in Brazil and Paraguay, a certain quantity being exported from both these countries. It is these republics, too, as well as the north-eastern corner of Argentina, that produce the *yerba maté*, or Paraguayan tea, appreciated in many countries of South America.

Fruits such as the guava and mango abound in the tropical regions; but these, although of great utility in the matter of home consumption, are of little value for export. Pineapples of very fine quality are now shipped in considerable quantities from Pernambuco, on the Brazilian coast.

The cultivation of peaches, grapes, pears, and other fruits of the kind is carried on largely in Argentina, Chile, Uruguay, and Southern Brazil. Two of the most famous orange-producing countries are Brazil and Paraguay, in addition to which this fruit grows with extraordinary abundance in the north of the continent. The finest wines are produced in Chile, some of the vintages of that Republic comparing favourably with those of Europe.

The most important livestock districts of South America are in Argentina, Uruguay, Chile, Southern Brazil, and Southern Paraguay. The breeding industry is now the most important of all in these countries.

From the point of view of ports and harbours the coastline of South America offers a marked contrast in its Pacific and Atlantic shores. The Atlantic coastline offers anchorages in abundance, while, with the exception of the shores of Southern Chile, indented and island-strewn as they are, there is scarcely a littoral in the whole world that possesses fewer havens and natural shelters than the Pacific coast of South America.

Harbours

Brazil and Peru offer the two examples of the extremes. Whereas Brazil can count a dozen of absolutely first-class harbours—and among them one which is generally admitted to be the finest in the world—Peru cannot boast a single port that offers a natural safe anchorage, notwithstanding the very considerable length of its coastline.

In order to survey the most notable of these South American harbours one by one it is best to start from the north along the coast to the east of the Isthmus of Panama. The first port at which we arrive by this route is that of Cartagena in the Republic of Colombia. Cartagena possesses a good anchorage, but the commercial interest of the port is largely a matter of past history, when the coast in these regions reeked with fever, but overflowed with the gold brought from the Pacific coast to be sent on its way to Spain. Barranquilla, a modern port on the Magdalena River, has now to a great extent taken the place of Cartagena. Barranquilla, by the way, is connected with Savanilla, another Colombian port, by railway.

Proceeding to the east, we come to the Venezuelan coast and to the port of Maracaibo, situated in a sheltered spot on the bank of the large and almost landlocked inlet of Maracaibo. To the east of this is Puerto Cabello, another fine harbour, while a little to the east of this again is La Guaira, which, although the chief harbour of Venezuela, does not offer such marked natural advantages as the two previously mentioned harbours.

Dipping down now to the south-east, the low-lying shores of the three Guianas present themselves. The first port of note here is Georgetown, the principal port of British Guiana, a safe, but somewhat muddy, anchorage, while New Amsterdam, a lesser port of this British Colony, resembles the first very closely in many respects. Paramaribo, the capital of Dutch Guiana, lies equally low, and Cayenne, the chief maritime centre of French Guiana, is a convict settlement, and notorious for its evil climate.

Dropping abruptly to the south from this latter point, the enormous estuary of the Amazon opens out to shelter within its inland basin almost as many river ports as the average country with a favourable coastline can boast of seaports along its marine frontiers.

The Amazon System

The first to be mentioned is Para. This is usually the first port of call for steamers bound from Europe for the great water highway of the Amazon. The town is an important centre of the rubber industry, as indeed, are practically all the ports of any size throughout the Amazon system.

The last port on the Amazon system at which ocean-going steamers can call is Iquitos, in Peru, a centre which is situated at a distance of nearly two thousand five hundred miles from the mouth of the stream! There is probably no other circumstance connected with the navigation of the Amazon which will so plainly reveal the gigantic nature of this greatest of the world's rivers.

At the eastern extremity of the continent is Pernambuco, or Recife, a town which is usually the first to be visited by steamers bound for Brazil and Argentina. A coral reef running parallel with the shore affords shelter for moderate-sized steamers, but the large new liners which are now concerned with the South American traffic are obliged to anchor outside, and are served by lighters.

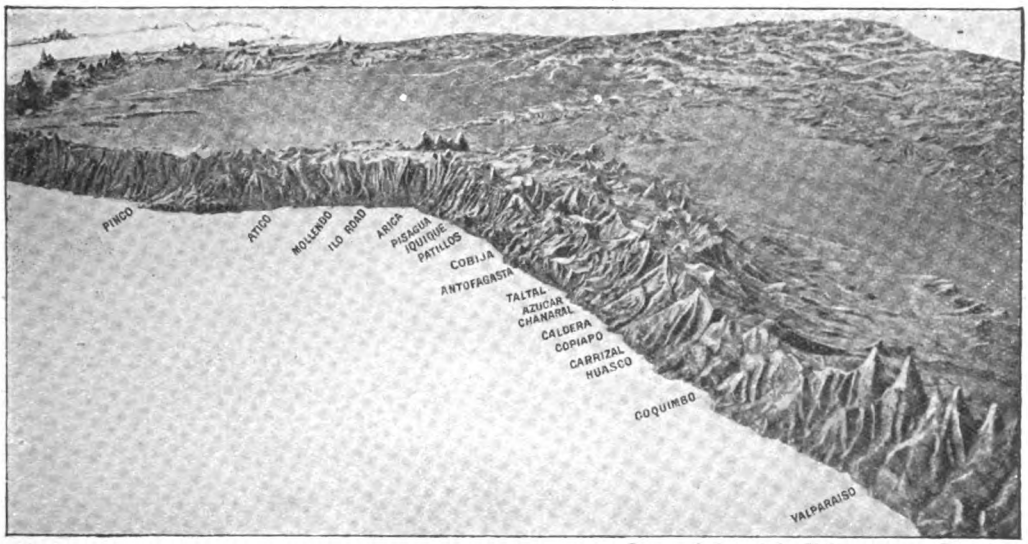
Five degrees or so further to the south is Bahia, the oldest port in Brazil, situated in a magnificent bay, which supplies a capacious anchorage to the picturesque town. To the south of this again, situated only just within the Tropic of Capricorn, is the wonderful landlocked bay of Rio de Janeiro, which is commonly held to be the most beautiful harbour in the world. Rio de Janeiro is a harbour which could in fact hold all the navies of the world.

Estuary of River Plata

The next Brazilian port of first-class importance is Santos, situated a few miles up a winding, broad river. The largest liners can anchor alongside the docks here. The place is famous for the fact that it handles more coffee than any other spot in the world.

We now arrive at the estuary of the River Plata and at the port of Montevideo, situated on its northern shore. Extensive harbour works have been erected here, and there is

A Brazilian Sugar Cane Plantation.



By permission of the Chilian Nitrate Committee.

SEA BOARD OF CHILE AND PERU

now a good anchorage in the inner harbour for vessels drawing up to nearly twenty-five feet of water.

Further within the estuary, and upon the opposite side, is the great port of Buenos Aires, the premier centre of shipping in the southern half of the new world. The docks here, having been largely added to of recent years, are now of vast extent. Some difficulty, however, is experienced in the channel leading from the mouth of the estuary to the port as the tendency is for this to become silted up by soil carried down by the river.

The chief river ports on the La Plata system are Rosario, Paraná, Santa Fé, Corrientes, and Asuncion, on the Paraná River; and Concepcion del Uruguay, Fray Bentos, Paysandú, Colón, Salto, and Concordia, on the twin stream of the Uruguay.

To return to the Atlantic coast, the port of Bahia Blanca, the Argentine Naval station, is by far the most important commercial centre on the coast between Buenos Aires and the south of the continent.

Chilian Ports

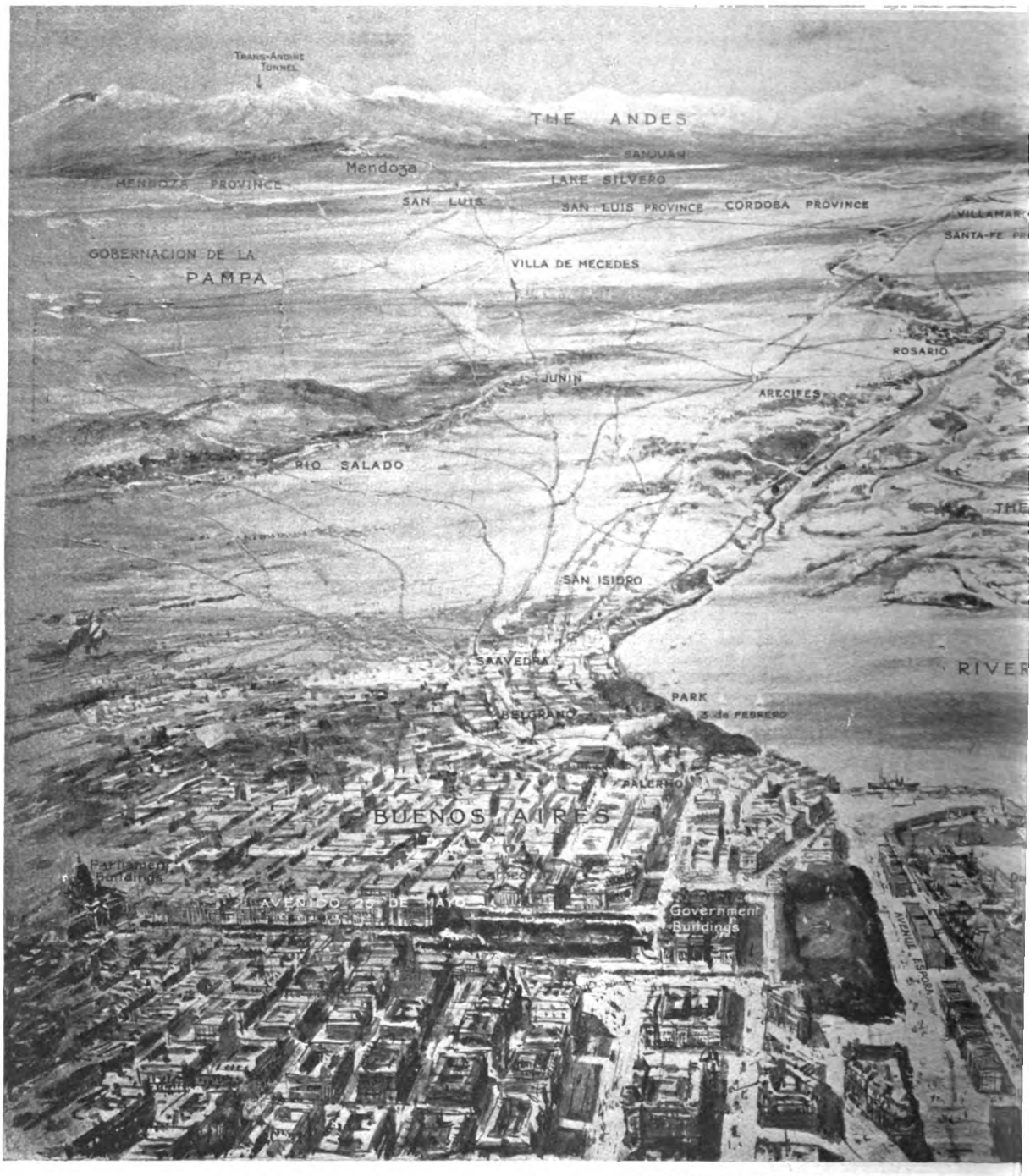
The last port to be dealt with on the Atlantic coast is Punta Arenas, situated in the Magellan Straits, and one of the most southerly towns in the world. Punta Arenas, the centre of a rapidly developing country, largely devoted to sheep-breeding, is on Chilian territory, and thus constitutes the only Chilian port of any importance which does not face the Pacific Ocean.

Following the plan of circumnavigating the continent, we may now enter the Pacific Ocean, and turn northwards along the Chilian coast. After skirting a broken shore and many archipelagoes of densely wooded islands, the approach to the populous districts and civilisation is heralded by Puerto Montt, a well sheltered port of recent construction, while a little to the north of this again is Corral, in a picturesque and landlocked bay, which serves as the port for the important southern Chilian town of Valdivia.

Valparaiso

To the north of this, again, Talcahuano, the naval port of Chile, and the commercial port of the large town of Concepcion, is the last harbour on the northward way along the Pacific to offer a naturally sheltered anchorage for practically the entire stretch of coast from this southerly point until the equator is all but reached. Valparaiso, the next coastal centre, ranks second in importance on the Pacific only to San Francisco in the United States. But even here the anchorage leaves something to be desired, and has only been protected from the ocean rollers by breakwaters erected at great expense. From the port of La Serena northwards the ports of northern Chile and of Peru are little beyond open roadsteads serving as best they may the desert and highly mineralised coast of these regions.

Callao, the port of Lima, the capital of Peru, is provided with a fine artificially constructed harbour, and ranks as the third port on the Pacific coast. Trujillo, the second port of Peru, is a less modern centre of commerce so far as equipment is concerned, but is nevertheless of no small importance. Payta, famous for its shipments



THE WONDERFUL CITIES AND

A bird's-eye view from above the centre of Buenos Aires. In the foreground are seen the streets and squares lines, including the line which runs to Chili by way of the Trans-Andine Tunnel. Ocean-going ships are shown River as far as Concepcion. The delta district

PLAINS OF ARGENTINA.

of the city and some of its busy docks. Stretching away from the city can be traced a network of railway on the River Plate, and smaller vessels proceeding up the Parana River as far as Rosario and the Uruguay between these rivers is a great cattle-raising country.

of Panama straw hats, is the most northerly of the Peruvian ports.

It is not until Guayaquil in Ecuador is reached that the long series of what are at the worst open roadsteads, and at the best artificial shelters, comes to an end. Guayaquil is situated at the junction of the rivers Guayaquil and Daule, and is thus amply provided with natural shelter. The situation of Guayaquil, moreover, is most picturesque, although its reputation for health is by no means one of the best.

The sole remaining Pacific ports of importance are Tumaco and Buenaventura on the Colombian coast. Both of these are concerned principally with the produce of vegetable ivory. Buenaventura is held by many to be the most beautiful spot on the Pacific shore.

Railway Enterprise

Very great strides have been made in the communications of South America during the last quarter of a century, and it is chiefly to the improved means of travel and transport that the great recent commercial and industrial advance of the continent is due.

The country in which the ramifications of the railways have been most developed is Argentina. Here the railway industry is rapidly becoming one of the most important in the world, and the amount of British capital which is invested in these enterprises is several hundred millions.

In the south, a great railway centre has been established in Bahia Blanca, and one of the most important moves in the railway history of the continent has been the linking up of Argentina and Chile by rail. To effect this the lines have had to be carried right across the Andes at a point between Mendoza on the Argentine side and Los Andes on the Chilian, a tunnel several miles long piercing the summit of the range in the neighbourhood of the gigantic mountain of Aconcagua.

The very notable achievements which have opened up railway communication between the countries bordering on the Estuary of the Rio de la Plata and the republics to the north are of still more recent date. It is now possible to travel by rail from Buenos Aires to Asuncion.

An equally important development in the railway traffic is that which now places Rio de Janeiro, the capital of Brazil, in direct communication with Montevideo, the capital of Uruguay. This has been effected by continuing the line which ran from Rio de Janeiro southward to São Paulo. This now traverses the southern Brazilian states of Paraná, Santa Catharina, and Rio Grande do Sul, and enters Uruguayan territory at the town of Rivera.

One of the most remarkable of the South American lines is the railway which runs from the Peruvian port of Mollendo on the Pacific coast to Cuzco by way of Lake Titicaca. This surmounts the Andes at a height of 14,660 feet. The famous Oroya railway to the north of this, which runs inland from Callao, the port of Lima, attains to an even greater height, crossing the summit of the range at an altitude of 15,645 feet, and is thus one of the loftiest lines in the world.

The Chilian railway system is naturally obliged to conform itself to the narrow and long strip of its country, and its general trend is thus due north and south. Its southernmost point is Puerto Montt, and the most northern town which has the benefit of a railway service is Tacna, almost on the Peruvian frontier. The Chilian railway system will one day form an important part of the longitudinal railway which is planned to traverse the continent from north to south.

River Traffic

In the great Amazon basin, of course, railways are to a great extent rendered unnecessary by the vast ramifications of navigable rivers and channels which offer themselves. In addition to the ocean steamers which can penetrate along the main stream as far as the port of Iquitos in Peru, some two thousand five hundred miles from the mouth, there are numerous river steamers which ply along the shallower channels as well as along the main routes. The lesser craft consist of sailing boats provided with a raised and thatched cabin in the stern, and of canoes, the larger types of which are also provided with a similar cabin.

The navigation of the Rio de la Plata system is, of course, on a smaller scale than that of the Amazon. Some very fine river steamers ply on the Uruguay branch as far as Colon, where passengers are transferred to smaller vessels, which take them as far as Concordia, opposite which town the journey is interrupted by rapids.

On the Paraná, ocean-going steamers can proceed upstream as far as Rosario, and others of rather lesser draught as far as Santa Fé. Large river-steamers ply between the mouth of the river and Asuncion, the capital of Paraguay. Beyond this point it is possible by transferring into a smaller steamer to get as far as Corumbá. W. H. K.

Continued from page 48.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC. (M. A. Lewenz, M.A.[Lond.]).

ARITHMETIC.—XVIII

133. Stocks and Shares (*continued*)

Bonds.—These are printed papers issued by foreign governments acknowledging their indebtedness for certain sums.

Coupons are small certificates attached to bonds which can be detached and which entitle the holder to receive the guaranteed interest until the Bond is redeemed. Such interest is usually payable half-yearly.

Consols, meaning Consolidated Annuities, is that part of the British National Debt which consists of several stocks consolidated into one fund.

134. Brokerage

The agent who on the Stock Exchange buys and sells stocks and shares for the public is called a **Stock Broker.** The man on the Stock Exchange from whom the Broker buys, or to whom he sells, is called a **Stock Jobber.**

In the published lists of prices of stocks and shares there are usually two prices quoted, the lower one being that at which the Jobber buys, and the higher one being that at which he sells.

Brokers charge a commission for their services to the public, and this is called **Brokerage.** The amount of this commission is a matter of arrangement; on Consols it usually varies from $\frac{1}{16}$ to $\frac{1}{8}$ per cent.

Examples:—

(1) What quantity of stock in 3 per cents. at 75 can be bought for £1250 ?

£75 buys £100 of Stock

$\therefore$ £1 „ $\frac{£100}{75}$ „

$\therefore$ £1250 buys $\frac{£100 \times 1250}{75}$ of Stock =

£1666 13s. 4d.

(2) A man invested £1600 in 4 % Stock at 92. What dividend did he get, and what was the rate of interest he obtained for his money ?

£92 of stock gets a dividend of £4

$\therefore$ £1 „ „ „ „ „ $\frac{£4}{92}$

$\therefore$ £1600 „ „ „ „ „ $\frac{£4}{92} \times 1600$

= £69 11s. 4d. to nearest penny.

Interest on £1 $= £\frac{4}{92} = £\frac{1}{23}$

$\therefore$ „ £100 $= £\frac{100}{23} = £4\frac{8}{23}$.

Hence his dividends amounted to **£69 11s. 4d** and he got $\mathbf{4\frac{8}{23}}$ % interest for his money.

(3) Which would be the better investment, 3 % stock at $87\frac{3}{8}$ or shares at £233 each on each of which a dividend of £7 13s. 4d. is paid annually ? What sum must be invested in the former to produce an annual income of £460, and what in the latter ?

Rate of interest in first case.

Interest on £$87\frac{3}{8}$ is £3

„ „ £1 „ $£\frac{3}{87\frac{3}{8}}$

„ „ £100 $= £\frac{3 \times 8 \times 100}{699} = 3\frac{101}{233}$

Rate of interest in second case.

Interest on £233 $= £7\frac{2}{3}$

„ „ £100 $= £\frac{23 \times 100}{233 \times 3} = 3\frac{203}{699}$.

Now $3\frac{101}{233} > 3\frac{203}{699}$ $\therefore$ the former investment is better.

Again £3 is produced by £$87\frac{3}{8}$

$\therefore$ £460 „ „ $£\frac{460 \times 699}{3 \times 8} = £13397\ 10s.$

And £$7\frac{2}{3}$ is produced by £233

$\therefore$ £460 „ „ $£\frac{233 \times 460 \times 3}{23}$

= £13980

Hence **£13397 10s.** must be invested in the **former,** and **£13980** must be invested in the **latter.**

Note.—The answer to the first part of the question might have been deduced from the fact that a smaller sum invested in the former will produce the same income as a larger sum invested in the latter.

(4) Find the change in income by transferring £956 from 3 % stock at $75\frac{1}{8}$ to $4\frac{1}{2}$ % stock at $101\frac{1}{2}$. Brokerage being $\frac{1}{8}$ %.

Brokerage is charged both to the buyer and the seller, hence on selling the first stock the holder will get £$75\frac{1}{8}$ — £$\frac{1}{8}$ = £75 for £100 of stock; similarly for the second stock he will have to pay £$101\frac{1}{2}$ + £$\frac{1}{8}$ = £$101\frac{5}{8}$ for £100 of stock.

In 3 % stock £75 produces income of £3

$\therefore$ £1 „ „ $£\frac{1}{25}$

In $4\frac{1}{2}$ % stock $£101\frac{5}{8}$ „ „ $£4\frac{1}{2}$

$\therefore$ £1 „ „ $£\frac{12}{271}$

Change in income per £1

$= £\frac{12}{271} - £\frac{1}{25} = £\frac{29}{271 \times 25}$

$\therefore$ total increase in income $= £\frac{29}{271 \times 25} \times 956$

= **£4 1s. 10d.** to nearest penny.

(5) English Consols stand at $77\frac{7}{16}$, and pay $2\frac{1}{2}$ %, income tax at 1s. 2d. in the pound being deducted from the interest. French Rentes stand at $94\frac{1}{2}$ and pay 3 % free of income tax. Find which is the better investment, and, to the nearest penny, by how much the yields differ per £100 of capital invested (*London Matric. Exam.*).

1s. 2d. in the pound $= \frac{7}{120}$ of income.

$\therefore$ the man actually receives $\left(1 - \frac{7}{120}\right) = \frac{113}{120}$ of gross income.

$\therefore$ income he derives from $£77\frac{7}{16}$ invested in consols

$= \frac{113}{120}$ of $£2\frac{1}{2} = £\frac{113}{48}$.

Now suppose $£77\frac{7}{16} \times 94\frac{1}{2}$ be invested in each stock.

From Consols net interest $= £\frac{113}{48} \times 94\frac{1}{2}$

$= £222\frac{15}{32}$.

From French Rentes interest = £3 × $77\frac{7}{16}$

$= £232\frac{5}{16}$

$\therefore$ the **French Rentes are a better investment.**

Again the difference in income on $£77\frac{7}{16} \times 94\frac{1}{2}$

$= £232\frac{5}{16} - £222\frac{15}{32} = £9\frac{27}{32}$

$\therefore$ difference on £100 $= £\frac{100 \times 9\frac{27}{32}}{77\frac{7}{16} \times 94\frac{1}{2}} =$ **2s. 8d.**

to nearest penny.

135. Percentages. Profit and Loss

In many questions, besides those of Interest, it is convenient to express the ratio of one number to another as a **percentage,** i.e. in such a way that the second term of the ratio is the number 100.

Examples:—

(1) The population of a city is 1 million. It increases $1\frac{1}{2}$ % for 3 years in succession. What is the population at the end of 3 years.

1,000,000 = population
15,000 = increase at end of 1 year

1,015,000 = population at end of 1st year
15,225 = increase at end of 2nd year

1,030,225 = population at end of 2nd year
15,453 = increase at end of 3rd year

1,045,678 = population at end of 3 years.

(2) In a town of 13,000 inhabitants 6,630 are females; what is the percentage of males?

No. of males = 13000 − 6630 = 6370

$x : 100 : : 6370 : 13000$

$\therefore x = \frac{6370 \times 100}{13000} = 49.$

Hence **49** % of the inhabitants are males.

(3) A person buys an article and sells it so as to gain 5 %. If he had bought it at 5 % less and sold it for 1s. less, he would have gained 10 %. Find the cost price.

Suppose the cost price were 100 shillings. If he sold so as to gain 5 %, selling price would be $\frac{105}{100}$ of 100s. = 105 shillings.

If he bought for 5 % less, cost price would be $\frac{95}{100}$ of 100s. = 95 shillings,

and if he then sold so as to gain 10 %, selling price would be $\frac{110}{100}$ of 95s. = $104\frac{1}{2}$ shillings.

Thus, if the cost price is 100 shillings, under the given conditions he could sell at 105s. — $104\frac{1}{2}$s. = $\frac{1}{2}$ s. less.

$\therefore$ actual cost price : 100s. : : 1s. : $\frac{1}{2}$s.

i.e. actual cost price = 200s. = **£10.**

NOTE that problems such as these are more easily solved by algebraic methods.

(4) A man buys 10 cwt. of sugar at £2 5s. 6d. per cwt., 7 cwt. at £2 2s. per cwt., and 12 cwt. at £1 19s. 8d. per cwt. At what price per lb. must he sell the mixture so as to gain 16 % ?

10 cwt. cost £22 15s. 0d.
7 cwt. cost £14 14s. 0d.
12 cwt. cost £23 16s. 0d.

29 cwt. cost £61 5s. 0d.

$\therefore$ 1 lb. of mixture costs $\frac{1}{29 \times 112}$ of $£61\frac{1}{4}$

$\therefore$ to gain 16 % he must sell 1 lb. of mixture at $\frac{116}{100}$ of $\frac{1}{29 \times 112} \times £61\frac{1}{4} =$ **5¼d.**

(5) Assuming that a gallon of water weighs 10 lb., and contains 277·274 cubic inches, find the percentage error in the statement that a cubic foot of water weighs 1000 oz.

277·274 cb. in. of water weigh 10 lb. = 160 oz.

$\therefore$ 1728 „ „ „ „ $\frac{160 \times 1728}{277 \cdot 274}$ oz.

= 997·14 oz.

error on 1000 = 1000 − 997·1 = 2·9

$\therefore$ error on 100 = ·29

i.e. percentage error = **·29.**

136. Average

The method of dealing with averages will be seen from the following example.

Example:—

If 50 quarters of wheat are sold for 77s. 8d. per qr., and 100 quarters for 78s. 3d. per qr., what is the average price per bushel?

The object is to find what the price of each bushel would be, if the total price remained unchanged, and each bushel fetched the same price.

The total number of quarters = 100 + 50 = 150.

The total sum realised

$$= \left\{ \begin{array}{l} 50 \times 77\text{s. } 8\text{d. or £194 3s. 4d.} \\ + 100 \times 78\text{s. } 3\text{d. or £391 5s. 0d.} \end{array} \right. = \text{£585 8s. 4d.}$$

We divide this by the number of bushels to get the average price of each which

$$= \frac{\text{£585 8s. 4d.}}{150 \times 8} = \textbf{9s. 9d.}$$

Exercise 45

(1) How much stock at 127 can be bought for £2032 ?

(2) How much stock at 82 can be bought for £2132 ?

(3) How much stock at 93 can be bought for £1046 5s. ?

(4) How much will £2700 stock at 75 sell for ?

(5) How much will £1090 stock at 97 sell for ?

(6) Find the income derived from £2000, if $\frac{2}{5}$ of it be invested in 3 per cents. at 98 and the remainder in $3\frac{1}{2}$ per cents. at par.

(7) If one gets $4\frac{1}{2}$ % interest on capital by investing in $3\frac{1}{2}$ per cents., what is the price of the stock, and how much stock can be purchased for £2400 ?

(8) Which is the better investment, 3 per cents. at $90\frac{1}{2}$ or 4 per cents. at 101 ?

(9) A man has £3200 3 per cents. and sells them at $99\frac{1}{4}$; he invests the proceeds in shares at £56 a share —these shares pay 5 % interest on £45, the amount paid up on each share. How is his income affected by the transaction ?

(10) What is the half-yearly income derived from £12364 15s. 4d. 3% debentures after income tax at 1s. 3d. in the pound has been deducted ?

(11) A man has £5500 invested in 3 per cent. stock at 110 and £3800 in 5 per cent. stock at 95. He sells out and invests part of the proceeds in 3 per cent. stock at 105 and part in $5\frac{1}{2}$ per cent. stock at 99. How must the investments be apportioned, if there is no change in his income ?

(12) A town council repays a loan of £70,000 in half-yearly instalments of £1,000, together with simple interest at 5 % paid at the time of each repayment. If the first instalment be paid at the end of a year from the date of the loan, how much will the council pay altogether ?

(13) Find the dividend at the rate of 12s. $10\frac{1}{2}$d. in the £ on (*a*) £475 12s. 6d.

(*b*) 45 francs 37 centimes.

(*c*) 453 dollars 70 cents.

1 franc = 100 centimes ; 1 dollar = 100 cents.

(14) Find, to the nearest hundredth of a franc, the Simple Interest on 4712·85 francs for $3\frac{1}{2}$ years at $4\frac{1}{2}$ per cent. per annum ; and to the nearest penny, the compound interest on £41 10s. at 2·6 per cent. per annum, interest payable half-yearly.

NOTE.—Questions 11—14 are from the London Matric. Exam.

Key to Exercise 43

(1) £12 15s. (2) £71 5s. (3) £8 17s. 3d. (4) £24 1s. 3d. (5) £1,613 13s. $11\frac{1}{2}$d. (6) £112 8s. $1\frac{1}{2}$d. (7) £176 6s. 10d. (8) £17 11s. 1d. (9) £353 11s. 6d.

Key to Exercise 44

(1) £93 8s. 4d. ; £893 8s. 4d. (2) £36 7s. 11d. ; £267 2s. 5d. (3) £23 19s. 8d. ; £869 14s. 2d. (4) £16 8s. ; £146 8s. (5) £25 18s. 3d. ; £386 10s. 9d. (6) £5 7s. (7) £10 5s. 4d. (8) £240.

M. A. L.

ALGEBRA.—XVIII

107(*a*). IN Lesson IV. (Vol. I., p. 244), we established the following Laws of Indices.

I. (α) $a^m \times a^n = a^{m+n}$

(β) $a^m \times a^n \times a^p \times \ldots = a^{m+n+p+\cdots}$

II. (α) $a^m \div a^n = a^{m-n}$ where $m > n$.

(β) $a^m \div a^n = \dfrac{1}{a^{n-m}}$ where $n > m$.

III. $(a^m)^n = a^{mn}$

IV. $(a \times b \times c \times \cdots)^m = a^m \times b^m \times c^m \times \cdots$

V. $(a \div b)^m = \dfrac{a^m}{b^m}$

Our definition of a power, however, ceases to have any meaning when the index is not a positive integer, and the question now arises whether we can attach any meaning to fractional, negative, and zero indices.

We shall define fractional, negative, and zero indices so that they obey the fundamental Index Law I. α which was derived from first principles.

If n is considered a positive integer, $\sqrt[n]{a}$ may be defined as the quantity whose nth power is a. There is, however, an important distinction between roots and powers, for while there is only one nth power of a, there is more than one nth root.

For example $4^2 = 16$ i.e. the second power of 4 is 16 ; but $\sqrt{4} = +2$ or -2, i.e. there are two square roots of 4. Here 2 is the real positive value of $\sqrt{4}$ and it is only with the real positive value of $\sqrt[n]{a}$ that we shall deal at present. This is sometimes called the Principal Value of the nth root.

108. *To find the meaning of $a^{\frac{m}{n}}$ where m and n are positive integers.*

By I. $a^{\frac{m}{n}} \times a^{\frac{m}{n}} = a^{\frac{m}{n}+\frac{m}{n}} = a^{\frac{2m}{n}}$

$a^{\frac{m}{n}} \times a^{\frac{m}{n}} \times a^{\frac{m}{n}} = a^{\frac{m}{n}+\frac{m}{n}+\frac{m}{n}} = a^{\frac{3m}{n}}$

and $a^{\frac{m}{n}} \times a^{\frac{m}{n}} \times a^{\frac{m}{n}} \times \ldots$ to n factors

$= a^{\left(\frac{m}{n}+\frac{m}{n}+\frac{m}{n}+\ \ldots\ \text{to } n \text{ terms}\right)} = a^{n \times \frac{m}{n}} = a^m$

Now by our definition of a power a^m is the nth power of the nth root of a^m.

But above we have taken $a^{\frac{m}{n}}$ n times as a factor.

i.e. we have raised $a^{\frac{m}{n}}$ to the nth power.

Hence a^m is the nth power of $a^{\frac{m}{n}}$

$\therefore a^{\frac{m}{n}}$ is the nth root of a^m, i.e. $a^{\frac{m}{n}} = \sqrt[n]{a^m}$.

Thus $27^{\frac{2}{3}} = \sqrt[3]{27^2} = 9$; $25^{\frac{3}{2}} = \sqrt{25^3} = 125$; $32^{\frac{1}{5}} = \sqrt[5]{32} = 2$.

To find the meaning of a zero index.

By I. $a^r \times a^s = a^{r+s}$.

Now put $s = 0$

Then $a^r \times a^0 = a^{r+0} = a^r$.

$$\therefore a^0 = \frac{a^r}{a^r} = 1$$

However great or small a may be, a^0 always $= 1$. Thus $10{,}000^0 = 1$; $6^0 = 1$; $\left(\dfrac{1}{100000}\right)^0 = 1$.

Lastly let us find the meaning of a negative index.

By I. $a^{p-r} \times a^r = a^{p-r+r} = a^p$

again by I. $a^p \times a^{-r} = a^{p-r}$

$\therefore a^{p-r} \times a^r \times a^p \times a^{-r} = a^p \times a^{p-r}$

$\therefore a^r \times a^{-r} = 1$

$\therefore a^{-r} = \frac{1}{a^r}$

Thus $9^{-2} = \frac{1}{9^2} = \frac{1}{81}$; $8^{-\frac{1}{3}} = \frac{1}{\sqrt[3]{8}} = \frac{1}{2}$

109. Having found the above intepretations of fractional, zero and negative indices, which obey the fundamental Index Law I., it remains to show that the other Index Laws also hold good for these interpretations.

(1) *To show that if n be a positive integer*

$a^{\frac{1}{n}} \times b^{\frac{1}{n}} = (ab)^{\frac{1}{n}}$

Put $x = a^{\frac{1}{n}} \times b^{\frac{1}{n}}$

$x^n = x \times x \times x \ldots\ldots$ to n factors

$= (a^{\frac{1}{n}} \times b^{\frac{1}{n}}) \times (a^{\frac{1}{n}} \times b^{\frac{1}{n}}) \times \ldots\ldots$ to n factors

$= a^{\frac{1}{n}} \times a^{\frac{1}{n}} \times \ldots\ldots$ to n factors $\times b^{\frac{1}{n}} \times b^{\frac{1}{n}} \times \ldots\ldots$ to n factors

$= ab$

$\therefore x = \sqrt[n]{ab} = (ab)^{\frac{1}{n}}$

(2) Similarly we may show that $\frac{a^{\frac{1}{n}}}{b^{\frac{1}{n}}} = \left(\frac{a}{b}\right)^{\frac{1}{n}}$

(3) Also by repeated application of the above $a^{\frac{1}{n}} \times b^{\frac{1}{n}} \times c^{\frac{1}{n}} \times \ldots\ldots = (a\ b\ c\ \ldots\ldots)^{\frac{1}{n}}$

As a particular case of this last, suppose there are m letters a, b, c, d ....., and then suppose each letter $= a$

then $(a^{\frac{1}{n}})^m = (a^m)^{\frac{1}{n}} = \sqrt[n]{a^m}$

Now n and m are positive integers $\therefore a^{\frac{m}{n}}$ is known to be $\sqrt[n]{a^m}$, and hence $(a^{\frac{1}{n}})^m = (a^m)^{\frac{1}{n}} = \sqrt[n]{a^m} = a^{\frac{m}{n}}$.

(4) *To show that if m and n are positive integers* $(a^{\frac{1}{n}})^{\frac{1}{n}} = a^{\frac{1}{mn}}$

Put $x = (a^{\frac{1}{m}})^{\frac{1}{n}}$

Then if $x = y^{\frac{1}{n}}$, $x = \sqrt[n]{y}$ $\therefore x^n = y$

Now if $y = a^{\frac{1}{m}}$, $x = (a^{\frac{1}{m}})^{\frac{1}{n}}$

$\therefore x^n = a^{\frac{1}{m}}$

$\therefore (x^n)^m = (a^{\frac{1}{m}})^m = a$

$\therefore x^{mn} = a$

$\therefore x = \sqrt[mn]{a} = a^{\frac{1}{mn}}$.

(5) *If m, n and p are positive integers, to show that*

$a^{\frac{m}{n}} = a^{\frac{pm}{pn}}$

Put $x = a^{\frac{m}{n}} = \sqrt[n]{a^m}$

then $x^n = (\sqrt[n]{a^m})^n = a^m$

and $(x^n)^p = (a^m)^p$

$\therefore x^{pn} = a^{pm}$ $\therefore x = \sqrt[pn]{a^{pm}} = a^{\frac{pm}{pn}}$

i.e. $a^{\frac{m}{n}} = a^{\frac{pm}{pn}}$

110. *From the above results we may prove that*

(i) $a^x \times a^y = a^{x+y}$

(ii) $(a^x)^y = a^{xy}$

for all values of x and y.

(6) *To show that* $a^x \times a^y = a^{x+y}$ *when x and y are positive fractions.*

Let $x = \frac{p}{q}$ and $y = \frac{r}{s}$

Then $a^x \times a^y = a^{\frac{p}{q}} \times a^{\frac{r}{s}} = a^{\frac{ps}{qs}} \times a^{\frac{qr}{qs}}$

$= (a^{ps})^{\frac{1}{qs}} \times (a^{qr})^{\frac{1}{qs}} = (a^{ps} \times a^{qr})^{\frac{1}{qs}} = (a^{ps+qr})^{\frac{1}{qs}}$

$= a^{\frac{ps+qr}{qs}} = a^{\frac{p}{q}+\frac{r}{s}} = a^{x+y}$

(7) Consider $\frac{a^x}{a^y}$ when x and are positive fractions.

Let $x = \frac{p}{q}$ and $y = \frac{r}{s}$

Then $\frac{a^x}{a^y} = \frac{a^{\frac{p}{q}}}{a^{\frac{r}{s}}} = \frac{a^{\frac{ps}{qs}}}{a^{\frac{qr}{qs}}} = \frac{(a^{ps})^{\frac{1}{qs}}}{(a^{qr})^{\frac{1}{qs}}} = \left(\frac{a^{ps}}{a^{qr}}\right)^{\frac{1}{qs}}$

Now (α) If $ps > qr$

then $\left(\frac{a^{ps}}{a^{qr}}\right)^{\frac{1}{qs}} = (a^{ps-qr})^{\frac{1}{qs}} = a^{\frac{ps-qr}{qs}}$

$= a^{\frac{p}{q}-\frac{r}{s}} = a^{x-y}$

and (β) If $ps < qr$

then $\left(\frac{a^{ps}}{a^{qr}}\right)^{\frac{1}{qs}} = \left(\frac{1}{a^{qr-ps}}\right)^{\frac{1}{qs}} = \frac{1^{\frac{1}{qs}}}{a^{\frac{qr-ps}{qs}}}$

$= \frac{1}{a^{\frac{r}{s}-\frac{p}{q}}} = a^{\frac{p}{q}-\frac{r}{s}} = a^{x-y}$

(8) Let y be negative and $= -z$ where z is positive, then $a^x \times a^y = a^x \times a^{-z} = a^x \times \frac{1}{a^z} = \frac{a^x}{a^z}$

$= a^{x-z} = a^{x+y}$

Let both x and y be negative and equal respectively to $-w$ and $-z$ where w and z are positive, then $a^x \times a^y = a^{-w} \times a^{-z} = \frac{1}{a^w} \times \frac{1}{a^z} = \frac{1}{a^w \times a^z}$

$= \frac{1}{a^{w+z}} = a^{-(w+z)} = a^{x+y}$

Hence we have proved that for all values of x and y, $a^x \times a^y = a^{x+y}$

(9) Before proving B, we must show that $a^{\frac{p}{q}} = \sqrt[q]{a^p}$ whatever p may be, q being a positive integer; we have so far only proved it when p is a positive integer.

Let $z = a^{\frac{p}{q}}$

then $z^q = a^{\frac{p}{q}} \times a^{\frac{p}{q}} \times a^{\frac{p}{q}} \times \ldots\ldots$ to q factors

$= a^{\frac{p}{q}+\frac{p}{q}+} \ldots\ldots$ to q terms

$\therefore z^q = a^p$

but q is a positive integer $\therefore z = \sqrt[q]{a^p}$

i.e. $a^{\frac{p}{q}} = \sqrt[q]{a^p}$

Now to prove that $(a^x)^y = a^{xy}$ for all values of x and y.

(α) If y is a positive integer

then $(a^x)^y = a^x \times a^x \times a^x \times \ldots\ldots$ to y factors
$= a^{x+x+x+} \ldots\ldots$ to y terms
$= a^{xy}$

(β) If y is a positive fraction, let it $= \frac{r}{s}$ then

$b^y = b^{\frac{r}{s}} = \sqrt[s]{b^r}$

Put $b = a^x$

then $(a^x)^y = \sqrt[s]{(a^x)^r} = \sqrt[s]{a^{xr}} = a^{\frac{xr}{s}} = a^{xy}$

(γ) If y be a negative quantity, let it $= -z$ where z is positive.

$b^y = b^{-z} = \frac{1}{b^z}$

Put $b = a^x$

then $(a^x)^y = \frac{1}{(a^x)^z} = \frac{1}{a^{xz}} = a^{-xz} = a^{xy}$

111. Irrational functions

The expression $x + \sqrt{y}$ is irrational unless y is a perfect square; that is to say from an arithmetical point of view $\sqrt{y}$ is incommensurable (unless y be a perfect square) for though we can calculate the arithmetical value of $\sqrt{y}$ to any degree of accuracy we choose, we can find no finite number which exactly $= \sqrt{y}$.

Similarly $\sqrt{x} + \sqrt{y}$ is irrational unless x and y are both perfect squares.

It is often convenient to find some factor or factors which when multiplied by the given irrational expression, will give a rational product. These are called **Rationalising Factors.**

These are mainly used in connection with fractional expressions of which the denominator is irrational. In the expression $\frac{1}{\sqrt{x}+\sqrt{y}}$ we can only obtain an approximately correct divisor, and any error in this divisor will be magnified in the quotient.

If, however, we multiply both numerator and denominator by $\sqrt{x} - \sqrt{y}$, then we get $\frac{1}{\sqrt{x}+\sqrt{y}}$

$= \frac{\sqrt{x}-\sqrt{y}}{(\sqrt{x}+\sqrt{y})(\sqrt{x}-\sqrt{y})} = \frac{\sqrt{x}-\sqrt{y}}{x-y}$

Here the divisor is quite accurate, and the error in the dividend will be decreased in the quotient.

The above rationalising is obtained from our knowledge of the identity $a^2 - b^2 = (a+b)(a-b)$. Thus the rationalising factor of $x \pm \sqrt{y}$ is $x \mp \sqrt{y}$.

That of $a\sqrt{b} \pm c\sqrt{d}$ is $a\sqrt{b} \mp c\sqrt{d}$.

To find the rationalising factor of $\sqrt{x} + \sqrt{y} + \sqrt{z}$

$(\sqrt{x} + \sqrt{y} + \sqrt{z})(\sqrt{x} + \sqrt{y} - \sqrt{z}) = x + y + 2\sqrt{xy} - z$

$\{(x + y - z) + 2\sqrt{xy}\}\{(x + y - z) - 2\sqrt{xy}\}$
$= (x + y - z)^2 - 4xy.$

Hence the rationalising factor is

$(\sqrt{x} + \sqrt{y} - \sqrt{z})\{(x + y - z) - 2\sqrt{xy}\}$

Consider $x + y - z - 2\sqrt{xy}$

$x + y - z - 2\sqrt{xy} = (\sqrt{x} - \sqrt{y})^2 - (\sqrt{z})^2$
$= (\sqrt{x} - \sqrt{y} + \sqrt{z})(\sqrt{x} - \sqrt{y} - \sqrt{z})$

Hence we may write the rationalising factor in the following form: $(\sqrt{x} + \sqrt{y} - \sqrt{z})(\sqrt{x} - \sqrt{y} + \sqrt{z})(\sqrt{x} - \sqrt{y} - \sqrt{z})$ in which its connection with the expression to be rationalised is clearly seen.

112. *To find the rationalising factor of any binominal surd* $ax^{\frac{p}{q}} \pm by^{\frac{r}{s}}$

Put $X = ax^{\frac{p}{q}}$ $Y = by^{\frac{r}{s}}$, and let n = L.C.M. of q and s, supposing $\frac{p}{q}$ and $\frac{r}{s}$ to be in their lowest terms.

Then $X \pm Y$ is the surd.

$X^n = (ax^{\frac{p}{q}})^n = a^n x^{\frac{np}{q}}$ which is rational since n contains q an exact number of times.

Similarly $Y^n = (by^{\frac{r}{s}})^n = b^n y^{\frac{nr}{s}}$ is rational.

Now we know that

$(X - Y)(X^{n-1} + X^{n-2}Y + X^{n-3}Y^2 + \ldots\ldots + XY^{n-2} + Y^{n-1}) = X^n - Y^n.$

Hence $X^{n-1} + X^{m-2}Y + \ldots\ldots + XY^{n-2} + Y^{n-1}$ is the rationalising factor of $X - Y$.

To find the rationalising factor of $X + Y$, put $Y = -Z$ in the above,

then $(X + Z)(X^{n-1} - X^{n-2}Z + X^{n-3}Z^2 - \ldots\ldots + (-1)^{n-1}Z^{n-1}) = X^n - (-1)^n Z^n$

and this enables us to rationalise $X + Y$.

113. To find the rationalising factor of $a + bx^{\frac{1}{3}} + cx^{\frac{2}{3}}$

Consider the identity

$(M + N + P)(M^2 + N^2 + P^2 - NP - PM - MN) = M^3 + N^3 + P^3 - 3MNP$

In this put $M = a$, $N = bx^{\frac{1}{3}}$ and $P = cx^{\frac{2}{3}}$.

Then $M^3 = a^3$, $N^3 = b^3x$, $P^3 = c^3x^2$ and $MNP = abcx$. and $\therefore$ rationalising factor is (*see p.* 104):—

$$a^{\frac{1}{3}}x^{-\frac{1}{3}} - 1 + a^{-\frac{1}{3}}x^{\frac{1}{3}})\, ax^{-1} + 2 + a^{-1}x\,(a^{\frac{2}{3}}x^{-\frac{2}{3}} + a^{\frac{1}{3}}x^{-\frac{1}{3}} + a^{-\frac{1}{3}}x^{\frac{1}{3}} + a^{-\frac{2}{3}}x^{\frac{2}{3}}$$

$$ax^{-1} - a^{\frac{2}{3}}x^{-\frac{2}{3}} + a^{\frac{1}{3}}x^{-\frac{1}{3}}$$

$$a^{\frac{2}{3}}x^{-\frac{2}{3}} + a^{\frac{1}{3}}x^{-\frac{1}{3}} + 2 + a^{-1}x$$

$$a^{\frac{2}{3}}x^{-\frac{2}{3}} - a^{\frac{1}{3}}x^{-\frac{1}{3}} + 1$$

$$1 + a^{-1}x$$

$$1 - a^{-\frac{1}{3}}x^{\frac{1}{3}} + a^{-\frac{2}{3}}x^{\frac{2}{3}}$$

$$a^{-\frac{1}{3}}x^{\frac{1}{3}} - a^{-\frac{2}{3}}x^{\frac{2}{3}} + a^{-1}x$$

$$a^{-\frac{1}{3}}x^{\frac{1}{3}} - a^{-\frac{2}{3}}x^{\frac{2}{3}} + a^{-1}x$$

$$\ldots\ldots\ldots\ldots\ldots\ldots$$

Hence $\frac{ax^{-1} + a^{-1}x + 2}{a^{\frac{1}{3}}x^{-\frac{1}{3}} + a^{-\frac{1}{3}}x^{\frac{1}{3}} - 1} = a^{\frac{2}{3}}x^{-\frac{2}{3}} + a^{\frac{1}{3}}x^{-\frac{1}{3}} + a^{-\frac{1}{3}}x^{\frac{1}{3}} + a^{-\frac{2}{3}}x^{\frac{2}{3}}$

$a^2 + b^2x^{\frac{2}{3}} + c^2x^{\frac{4}{3}} - bcx - acx^{\frac{2}{3}} - abx^{\frac{1}{3}}$
$= a^2 - abx^{\frac{1}{3}} + (b^2 - ac)x^{\frac{2}{3}} - bcx + c^2x^{\frac{4}{3}}$

114. Examples on indices and surds

(1) Simplify $(ab^{-2}c^3)^{\frac{1}{2}} \times (a^3b^2c^{-3})^{\frac{1}{3}}$

$(ab^{-2}c^3)^{\frac{1}{2}} \times (a^3b^2c^{-3})^{\frac{1}{3}} = a^{\frac{1}{2}}b^{-1}c^{\frac{3}{2}} \times ab^{\frac{2}{3}}c^{-1}$
$= a^{\frac{3}{2}}b^{-\frac{1}{3}}c^{\frac{1}{2}} = \frac{a^{\frac{3}{2}}c^{\frac{1}{2}}}{b^{\frac{1}{3}}}$

(2) Simplify $\dfrac{ax^{-1} + a^{-1}x + 2}{a^{\frac{1}{3}}x^{-\frac{1}{3}} + a^{-\frac{1}{3}}x^{\frac{1}{3}} - 1}$

First arrange divisor and dividend in ascending powers of x.

The example is worked out on p. 103, to which the student should turn and pay careful attention.

(3) Simplify $\sqrt{\{(x + x^{-1})^2 - 4(x - x^{-1})\}}$

$\sqrt{\{(x + x^{-1})^2 - 4(x - x^{-1})\}} =$
$\sqrt{\{x^2 + 2 + x^{-2} - 4x + 4x^{-1}\}}$
$= \sqrt{\{x^2 - 4x + 2 + 4x^{-1} + x^{-2}\}} =$
$\sqrt{\{x - 2 - x^{-1}\}^2} = x - 2 - x^{-1}$

(4) If $x^{\frac{1}{3}} + y^{\frac{1}{3}} + z^{\frac{1}{3}} = 0$ show that $(x + y + z)^3 = 27xyz$.

From the identity $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - bc - ca - ab)$
we have $x + y + z - 3x^{\frac{1}{3}}y^{\frac{1}{3}}z^{\frac{1}{3}}$
$= (x^{\frac{1}{3}} + y^{\frac{1}{3}} + z^{\frac{1}{3}})(x^{\frac{2}{3}} + y^{\frac{2}{3}} + z^{\frac{2}{3}} - y^{\frac{1}{3}}z^{\frac{1}{3}} - z^{\frac{1}{3}}x^{\frac{1}{3}} - x^{\frac{1}{3}}y^{\frac{1}{3}})$
but $x^{\frac{1}{3}} + y^{\frac{1}{3}} + z^{\frac{1}{3}} = 0$
$\therefore x + y + z - 3x^{\frac{1}{3}}y^{\frac{1}{3}}z^{\frac{1}{3}} = 0$
$\therefore x + y + z = 3x^{\frac{1}{3}}y^{\frac{1}{3}}z^{\frac{1}{3}}$
$\therefore (x + y + z)^3 = 27xyz.$

Exercise 26

Simplify the following :—

(1) $\sqrt{25^{-1}}$. (2) $64^{\frac{2}{3}}$. (3) $\sqrt{a^{-2}b} \times \sqrt[b]{ab^{-3}}$.

(4) $(a^{\frac{y+z}{z-x}})^{\frac{1}{x-y}} \times (a^{\frac{z+x}{x-y}})^{\frac{1}{y-z}} \times (a^{\frac{x+y}{y-z}})^{\frac{1}{z-x}}$

(5) $(x + x^{-1})^2(x^{\frac{1}{2}} - x^{-\frac{1}{2}})^3$.

(6) $(x^2 + 1 + x^{-2})(x^2 - 1 + x^{-2})$.

(7) $\dfrac{x^{\frac{3}{2}} - xy^{\frac{1}{2}} + x^{\frac{1}{2}}y - y^{\frac{3}{2}}}{x^{\frac{1}{2}} - y^{\frac{1}{2}}}$.

(8) $\dfrac{x - y}{x^{\frac{1}{3}} - x^{\frac{1}{6}}y^{\frac{1}{6}} + y^{\frac{1}{3}}} + \dfrac{x - y}{x^{\frac{1}{3}} + x^{\frac{1}{6}}y^{\frac{1}{6}} + y^{\frac{1}{3}}}$.

(9) Find the rationalising factors of
(a) $a^{\frac{1}{2}} - b^{\frac{1}{3}}$; (b) $x^{\frac{1}{3}} + y^{\frac{1}{3}} + z^{\frac{1}{3}}$.

(10) Show that
$\dfrac{x^2 + y^2 - x^{-2} - y^{-2}}{x^2y^2 - x^{-2}y^{-2}} + \dfrac{(x - x^{-1})(y - y^{-1})}{xy + x^{-1}y^{-1}} = 1.$

Key to Exercise 25

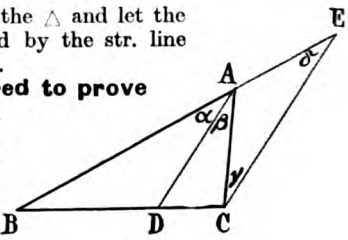
(4) $x = 2$, $y = 10$. (5) $x = 6$, $y = 8$. (6) $x = -2$, $y = 4$. (7) $2x^2 - 9x - 12 = 0$. (8) (i) $x = -1$, $-\cdot62$ or $1\cdot62$; (ii) $x = 1\cdot135$.

M. A. L.

GEOMETRY.—XVII

Proposition 104. Theorem

The straight line which bisects an angle of a triangle divides the opposite side into segments having the same ratio to one another as the sides containing the bisected angle.



Let A B C be the △ and let the ∠ A be bisected by the str. line cutting B C at D.

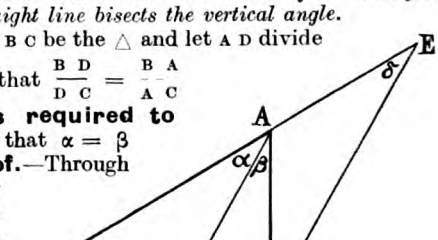
It is required to prove that $\frac{B\ D}{D\ C} = \frac{B\ A}{A\ C}$

Proof.—Through C draw a line ‖ to D A cutting B A produced in E.

Then $\beta = \gamma$ and $\alpha = \delta$ (Prop. 26)
but $\alpha = \beta \therefore \delta = \gamma \therefore$ △ A C E is isos. (Prop. 7)
$\therefore$ A E = A C
Now $\because$ D A is ‖ to C E
$\frac{B\ A}{A\ E} = \frac{B\ D}{D\ C}$ (Prop. 102)
$\therefore \frac{B\ A}{A\ C} = \frac{B\ D}{D\ C}$

Proposition 105. Theorem. (Converse of Prop. 104)

If a straight line drawn from the vertex of a triangle divide the base into segments having the same ratio to one another as the other two sides of the triangle, that straight line bisects the vertical angle.



Let A B C be the △ and let A D divide B C so that $\frac{B\ D}{D\ C} = \frac{B\ A}{A\ C}$

It is required to prove that $\alpha = \beta$

Proof.—Through C draw a line ‖ to A D meeting B A produced in E.

Then $\frac{B\ D}{D\ C} = \frac{B\ A}{A\ E}$ (Prop. 102)
but $\frac{B\ D}{D\ C} = \frac{B\ A}{A\ C}$
$\therefore$ A E = A C i.e. △ A C E is isosceles.
$\therefore \gamma = \delta$ (Prop. 6)
but $\gamma = \beta$, $\delta = \alpha$ $\because$ A D ‖ to E C (Prop. 26)
$\therefore \alpha = \beta$
i.e. A D bisects ∠ B A C.

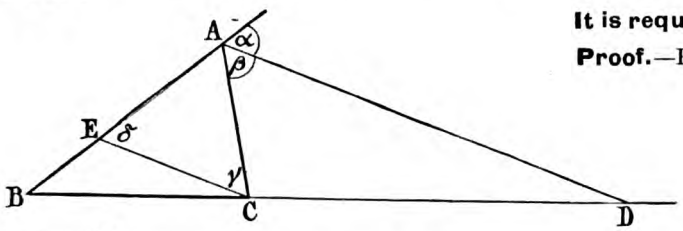
Proposition 106. Theorem

If the straight line bisecting the external angle of a triangle meet the opposite side produced, it divides it externally into segments having the same ratio to one another as the other two sides.

Let A B C be the △ and let the bisector of the external ∠ at A meet the opp. side B C produced in D.

It is required to prove that $\frac{BD}{DC} = \frac{BA}{AC}$

Proof.—Through C draw a line ‖ to DA meeting BA in E



$\left.\begin{matrix}\alpha = \delta \\ \beta = \gamma\end{matrix}\right\}$ ∵ EC ‖ to AD (Prop. 26)

but $\alpha = \beta$ ∴ $\gamma = \delta$ ∴ △ AEC is isos. (Prop. 7).

i.e. AE = AC

Now $\frac{BD}{DC} = \frac{BA}{AE}$ ∵ EC ‖ to AD (Prop. 102)

$$\therefore \frac{BD}{DC} = \frac{BA}{AC}$$

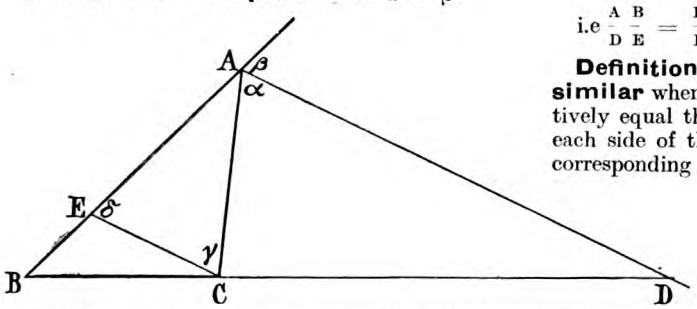
Proposition 107. Theorem. (Converse of Prop. 106)

If a straight line drawn from the vertex of a triangle divide the base externally into segments having the same ratio to one another as the other two sides of the triangle, that straight line bisects the external angle at the vertex.

Let ABC be the △ and let str. line AD divide the base BC externally so that

$$\frac{BD}{BC} = \frac{BA}{AC}$$

it is required to prove that $\alpha = \beta$



Proof.—Draw a str. line through C ‖ to DA cutting AB in E

Then $\frac{BD}{DC} = \frac{BA}{AE}$ (Prop. 102)

But $\frac{BD}{DC} = \frac{BA}{AC}$

∴ AE = AC i.e. △ AEC is isos.

∴ $\delta = \gamma$ (Prop. 6)

but $\left.\begin{matrix}\gamma = \alpha \\ \delta = \beta\end{matrix}\right)$ ∵ CE ‖ to DA (Prop. 26)

∴ $\alpha = \beta$

i.e. AD bisects the external ∠ at A

Proposition 108. Theorem

If the three angles of one triangle be equal to the three angles of another triangle, then each side of the first bears the same ratio to the corresponding side of the second.

Let ABC, DEF be the △s having

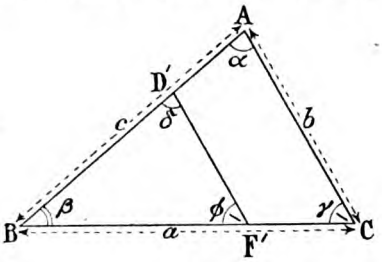
$\alpha = \delta$

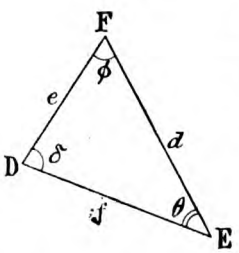
$\beta = \theta$

$\gamma = \varphi$

It is required to prove that $\frac{AB}{DE} = \frac{BC}{EF} = \frac{CA}{FD}$

Proof.—Place △ DEF on △ ABC so that E coincides with B and the arms of θ fall along the arms of β





Then DF will lie in the position D^1F^1

Now $\delta = \alpha$ ∴ D′F′ is ‖ to AC (Prop. 42)

$$\therefore \frac{c}{f} = \frac{a}{d}.$$

Similarly by placing the △ DEF on △ ABC so that D coincides with A and the arms of δ fall along the arms of α we may show that $\frac{c}{f} = \frac{b}{e}$

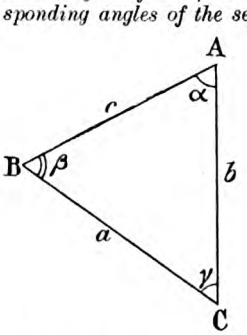
$$\therefore \frac{c}{f} = \frac{a}{d} = \frac{b}{e}$$

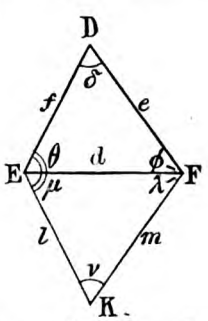
i.e $\frac{AB}{DE} = \frac{BC}{EF} = \frac{CA}{FD}$

Definition.—Two triangles are said to be **similar** when the angles of the first triangle respectively equal the angles of the second triangle and each side of the first bears the same ratio to the corresponding side of the second.

Proposition 109. Theorem. (Converse of Prop. 108)

If each side of one triangle bears the same ratio to the corresponding side of another triangle, then the three angles of the first respectively equal the corresponding angles of the second.





Let ABC, DEF be the △s having $\frac{a}{d} = \frac{b}{e} = \frac{e}{f}$

Required to prove that $\alpha = \delta$, $\beta = \theta$, $\gamma = \varphi$

Proof.—From F draw a line making $\lambda = \gamma$ and from E draw a line l making $\mu = \beta$

These lines cut at K

In $\triangle$s A B C, K E F since $\gamma = \lambda$, $\beta = \mu$ $\therefore \alpha = \nu$

$\therefore$ $\triangle$s A B C, K E F are similar (Prop. 108)

$$\therefore \frac{a}{d} = \frac{b}{m}, \text{ but } \frac{a}{d} = \frac{b}{e} \quad \therefore m = e$$

similarly $l = f$

$\therefore$ $\triangle$ K E F = $\triangle$ D E F (Prop. 8)

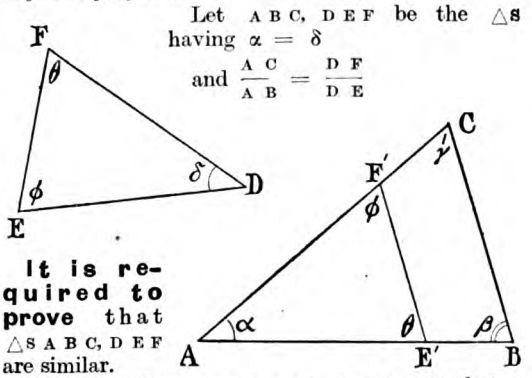
$\therefore \delta = \nu = \alpha$

$\theta = \mu = \beta$

$\varphi = \lambda = \gamma$

Proposition 110. Theorem

If an angle of one triangle be equal to an angle of another triangle, and if the sides containing the equal angles be proportional, then the triangles are similar.



Let A B C, D E F be the $\triangle$s having $\alpha = \delta$

and $\frac{A C}{A B} = \frac{D F}{D E}$

It is required to prove that $\triangle$s A B C, D E F are similar.

Proof.—Place $\triangle$ D E F on $\triangle$ A B C so that D coincides with A and the arms of δ fall along the arms of α

Then E F will lie in the position E′ F′

Now $\frac{A C}{A B} = \frac{D F}{D E} = \frac{A F'}{A E'}$ $\therefore$ E′ F′ is $\parallel$ to B C (Prop. 103)

$\therefore \theta = \beta$ and $\varphi = \gamma$ (Prop. 26)

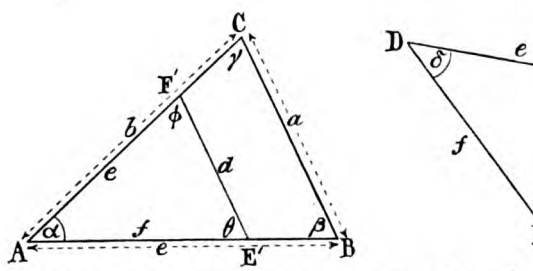
$\therefore$ $\triangle$s A B C, A E′ F′ are equiangular

i.e. $\triangle$s A B C, D E F are equiangular.

$\therefore$ they are similar (Prop. 108)

Proposition 111. Theorem

If two sides of one triangle be proportional to two sides of another, and the angles opposite one pair of corresponding sides be equal, then the angles opposite



the other pair of corresponding sides are (1) *equal, or* (2) *supplementary.*

Let A B C, D E F be two $\triangle$s having $\frac{a}{b} = \frac{d}{e}$ and $\alpha = \delta$

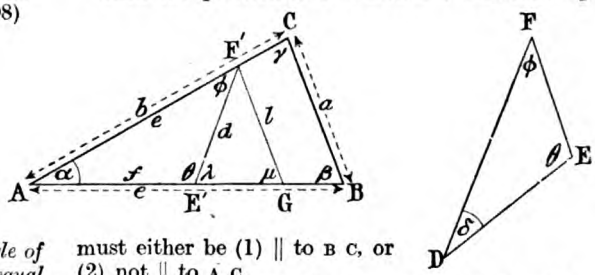
It is required to prove that

(1) $\theta = \beta$

or (2) $\theta + \beta = 2$ rt. $\angle$s.

Proof.—Place $\triangle$ D E F on $\triangle$ A B C so that D coincides with A and the arms of δ fall along the arms of α

Then the position E′ F′ which E F will take up



must either be (1) $\parallel$ to B C, or (2) not $\parallel$ to A C.

(1) Fig. 1. $\because$ E′ F′ is $\parallel$ to B C $\therefore \theta = \beta$ (Prop. 26)

(2) Fig. 2. Draw F′ G $\parallel$ to B C.

Then $\triangle$s A B C, A G F′ are equiangular

$$\therefore \frac{a}{b} = \frac{l}{e} \text{ (Prop. 108)}$$

but $\frac{a}{b} = \frac{d}{e}$ (hypothesis)

$$\therefore \frac{d}{e} = \frac{l}{e} \quad \therefore d = l \text{ i.e. } \triangle \text{ F′ E′ G is isos.}$$

$\therefore \lambda = \mu$ (Prop. 6)

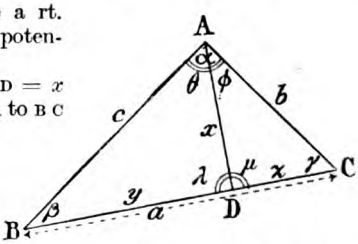
$\therefore \theta + \mu = \theta + \lambda = 2$ rt. $\angle$s

but $\mu = \beta$ $\because$ F′ G and C B are $\parallel$ (Prop. 26)

$\therefore \theta + \beta = 2$ rt. $\angle$s.

Proposition 112. Theorem

If a perpendicular be drawn to the hypotenuse of a right-angled triangle from the vertex opposite it, the triangles thus formed are similar to the original triangle.



Let A B C be a rt. $\angle$d $\triangle$ with hypotenuse B C

Let the $\perp$ A D = x be drawn from A to B C

It is required to prove that $\triangle$s D B A, D A C are similar to $\triangle$ A B C

Proof.—$\beta + \gamma = 1$ rt. $\angle$ ($\because \alpha = 1$ rt. $\angle$)

$\beta + \theta = 1$ rt. $\angle$ ($\because \lambda = 1$ rt. $\angle$)

$\therefore \theta = \gamma$

$\therefore$ the $\angle$s λ, β, θ of $\triangle$ D B A = $\angle$s α, β, γ of $\triangle$ A B C

$\therefore$ the $\triangle$s are similar

Similarly $\triangle$s D A C and A B C are similar.

Corollary.—The $\perp$ and the segments of the base are in continued proportion for $\frac{y}{x} = \frac{x}{z}$

(since $\triangle$s D B A, D A C are similar)

Proposition 113. Theorem

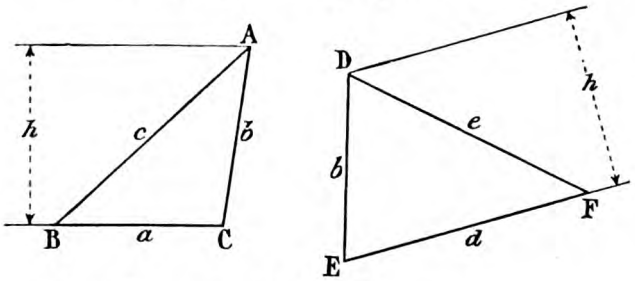
The ratio of the areas of triangles of equal heights is equal to the ratio of their bases.

Let A B C, D E F be two $\triangle$s of equal height h.

It is required to prove that

$$\frac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ D E F}} = \frac{\text{B C}}{\text{E F}}$$

Proof.—Area of $\triangle$ A B C $= \frac{1}{2} a h$ (Prop. 35, Cor. 1)
Area of $\triangle$ D E F $= \frac{1}{2} d h$



$$\therefore \frac{\text{Area of } \triangle \text{ A B C}}{\text{Area of } \triangle \text{ D E F}} = \frac{\frac{1}{2} a h}{\frac{1}{2} d h} = \frac{a h}{d h} = \frac{a}{d}$$

Corollary.—*The ratio of the areas of parallelograms of equal heights is equal to the ratio of their bases.*

Proposition 114. Theorem

If an angle of a triangle be equal to an angle of another triangle, the ratio of the areas of the triangles is the ratio of the products of the sides which contain the equal angles.

Let A B C, D E F be two $\triangle$s having $\alpha = \delta$

It is required to prove that

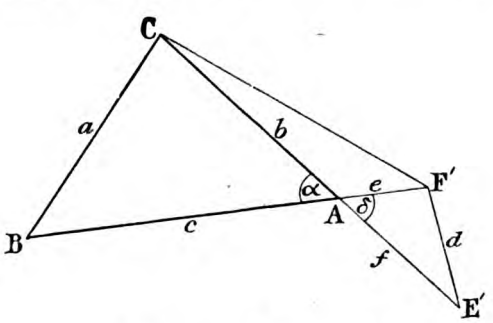
$$\frac{\text{area of A B C}}{\text{area of D E F}} = \frac{bc}{ef}$$

Proof.—Place $\triangle$ D E F so that D coincides with A and B A and D F are in one str. line and C A and D E are in one str. line. (This can be done $\because \alpha = \delta$)

Then E F will lie in position E′ F′.

Join C F′

$\triangle$s A B C, A F′ C are of same height, taking B A and A F′ as their bases.



$$\therefore \frac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ A F′ C}} = \frac{c}{e}$$

Similarly $\dfrac{\text{area of } \triangle \text{ A F′ C}}{\text{area of } \triangle \text{ A F′ E′}} = \dfrac{b}{f}$ (Prop. 113)

$$\therefore \frac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ A F′ C}} \times \frac{\text{area of } \triangle \text{ A F′ C}}{\text{area of } \triangle \text{ A F′ E′}} = \frac{c}{e} \times \frac{b}{f}$$

$$\therefore \frac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ A F′ E′}} = \frac{bc}{ef}$$

i.e. $$\frac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ D E F}} = \frac{bc}{ef}$$

Corollary.—*If an angle of one parallelogram equal an angle of another parallelogram, the ratio of the areas of the parallelograms is the ratio of the products of the sides which contain the equal angles.*

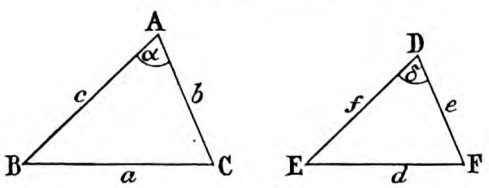
Proposition 115. Theorem

The ratio of the areas of similar triangles is the duplicate ratio of their sides.

Let A B C, D E F be similar $\triangle$s having $\frac{a}{d} = \frac{b}{e} = \frac{c}{f}$

It is required to prove that

$$\frac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ D E F}} = \frac{a^2}{d^2}$$



Proof.—$\alpha = \delta \therefore \dfrac{\text{area of } \triangle \text{ A B C}}{\text{area of } \triangle \text{ D E F}} = \dfrac{bc}{ef}$ (Prop. 113)

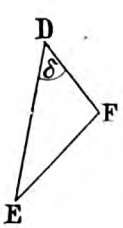
$$\frac{bc}{ef} = \frac{b}{e} \times \frac{c}{f} = \frac{a}{d} \times \frac{a}{d} = \frac{a^2}{d^2}$$

Exercise 20

(1) A B C is a triangle, and A P, C Q are the perpendiculars from A and C to the bisector of the angle B. Show that rectangle A P, B Q = rectangle B P, C Q.

(2) In the side A B of a triangle A B C, produced if necessary, a point D is taken such that A D is a third proportional to A B, A C. Show that the circle described about triangle B C D touches A C at C.

(3) Two circles intersect at A and B; P Q is a straight line through A terminated by the circles. Prove that the chords B P, B Q have the same ratio to one another as the diameters of the circles.



(4) A B C D is a quadrilateral in which A B and C D are parallel. The diagonals intersect at E. A line is drawn through E, parallel to A B, cutting A D at F and B C at G. Prove that F E = E G.

(5) A B C is a triangle; any straight line parallel to B C meets A B at D and A C at E; join B E and C D, meeting at F. Show that if A F be produced it will bisect B C.

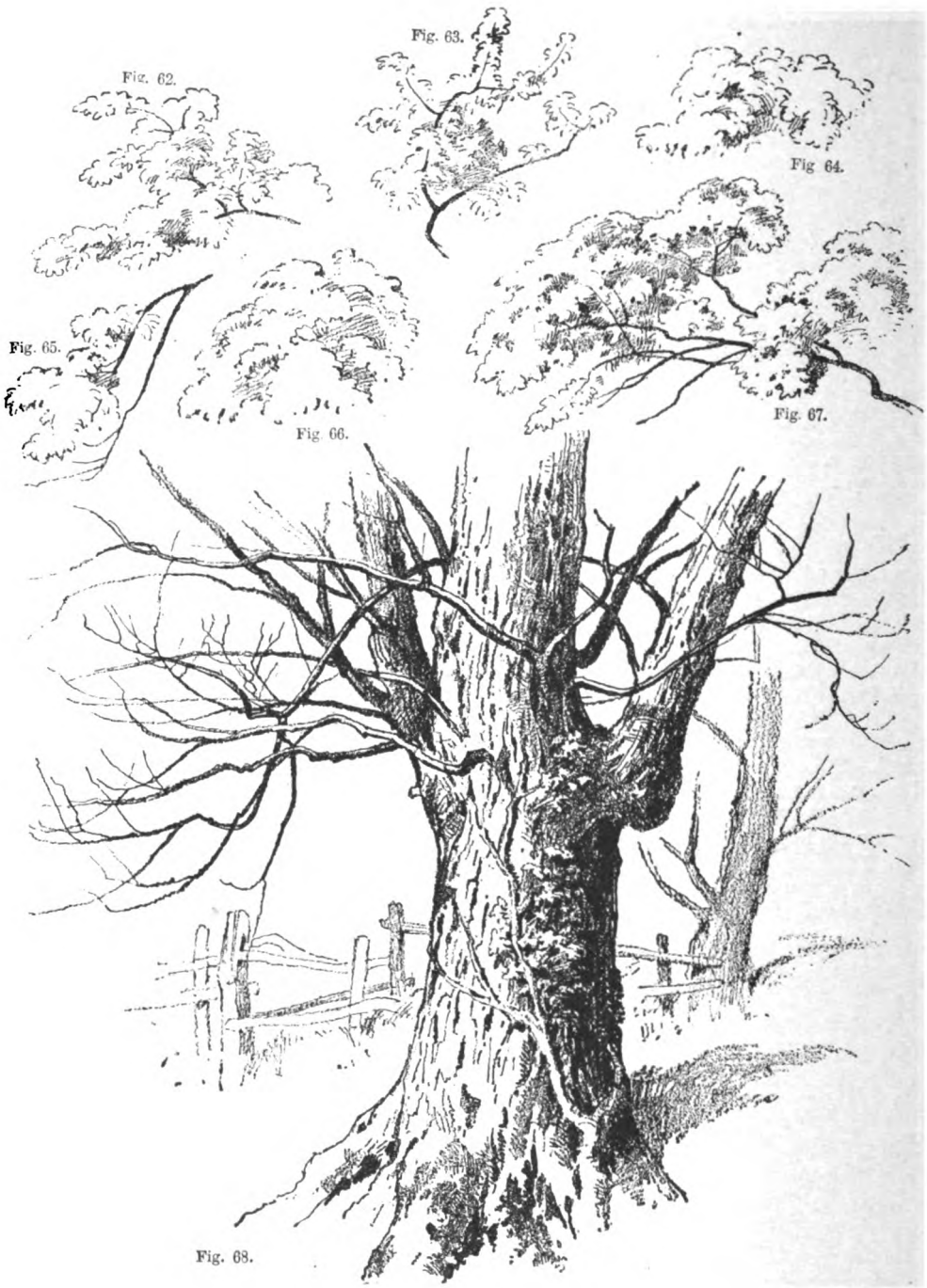
(6) P and Q are fixed points. A B and C D are fixed parallel straight lines; a straight line is drawn from P to meet A B at M and a straight line is drawn from Q parallel to P M, meeting C D at N; show that the ratio of P M to Q N is constant, and hence show that the straight line through M N passes through a fixed point.

(7) In a circle of radius 5 cm., calculate the lengths of chords at distances 1 cm., 2 cm., 2·5 cm., 3·78 cm. from the centre.

(8) A O B is a triangle. P is a point in A O, Q a point in B O such that angle O Q P equals angle O A B; show that the quadrilateral A B Q P is cyclic.

(9) Prove that a circle can be circumscribed about any quadrilateral whose sides are the bisectors of the angles of another quadrilateral.

M. A. L.



STUDIES IN FOLIAGE.

Among the many difficulties to be encountered in drawing foliage is the correct massing of light and shade. This is due largely to the absence of rigid outline. It is easy to lose the sense of form altogether when endeavouring to render the effects of light and shade.

Continued from Vol. II., page 498.

ART AND MUSIC:

Contributors **:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).**

DRAWING.—XI

In Vol. II., p. 495, mention was made of the use of casts. A few of these should be in the possession of every art student.

The advantages of plaster casts are many. For one thing, they can easily be placed in any position. You can arrange them in any light you require: you can observe them from every possible point of view, so that the practice to be derived from them is almost inexhaustible. We are about to discuss the art of drawing foliage, so that here it would be well to provide yourself with some casts of leaves or fruit. Ornaments and the more elaborate and complicated sort of cast can be left until later.

Foliage Drawing

The word foliage, for the purposes of art, is intended to include not merely the leaves on a tree or shrub, but all plants and vegetable growth of every description.

The strength and proportion of all vegetable growth depends upon its framework. To anyone unacquainted with the elements of natural history or to the great body of totally unobservant people, one tree is distinguished from another merely by its leaves. As a matter of fact, however, there is quite as much individuality about the way in which it is built as in its outward appearance in summer time.

A very little observation is required to show the difference in summer and in winter between the various species of trees. To take extreme instances, compare the branch growth of the oak and the poplar and the elm. Speaking generally, an oak tree has a tendency to throw out its branches almost at right angles with the trunk. The cedar does the same, but the differences are obvious in the bark and general appearance of the tree. A downward droop is characteristic of the willow and the exact opposite of the poplar, which sends its branches upwards parallel with the main growth of trunk which bears them.

There are, then, in the study of trees from the artist's point of view two main considerations. Firstly there are the main body of the tree and the branches which grow out of it, and secondly, the foliage which springs from the branches.

Begin your study of trees, then, in the winter for choice, when you can the more thoroughly appreciate the architecture of their growth. Remember that, amongst other things, the position and appearance of the foliage on each tree is governed by the position of its branches. Here once more you should do well to remember the old advice about *marking in* the relative positions of objects and their component parts.

First Stage

We will say that you are drawing a single tree—which is certainly the right course to pursue at the outset. Firstly then mark the position of the trunk, the point where it rises from the ground and its angle to the ground, if it is not precisely perpendicular. Then mark the place where the first branch springs out (generally, of course, the first is also the largest branch). Then notice how all the rest of the tree bears a relation to the trunk and largest branch. Observe the proportions of the tree as a whole from that point upwards.

Now add a few more points at various salient positions, so that you may see how much of the paper the tree will occupy. You can then begin to join up the first points, drawing in light outline the tree-trunk and largest branches, and then when you are satisfied that these preliminaries are accurate, go on to the smaller branches in turn, having first gone over your marked points once more to see that their position is perfectly correct relatively to each other.

Amongst the many difficulties you will have to encounter in the drawing of foliage is the correct massing of light and shade. The principal reason for this is the lack of strict and rigid outline. It is exceedingly easy to lose the sense of form altogether when attempting to render the forms of light and shade.

One of the greatest troubles in drawing from nature is that the eye is overburdened with richness of detail. You see so much that you have to pick and choose. You cannot put all that your eye grasps and understands into your drawing. You have to exercise the faculty of selection.

The great thing is to cultivate a broad vision, seeing and paying attention to what is essential only. Try not to let your eye rest too much upon the smaller details. Learn to see with an eye to effect. Masses of light and shade come more readily with distinct forms if observed through half-closed eyes.

Hard Practice

Turn now to Fig. 68. We have here a trunk of a tree, the lower branches and some small ones sprouting out both from the parent trunk and from larger branches. The method to be employed for the correct drawing of the framework has already been detailed. So, having practised on this figure by copying it, we can turn to the little drawings of foliage which accompany it. Figs. 62 to 67.

You should draw these again and again until you are thoroughly accustomed to them. It has happened continually in these lessons (and it will inevitably happen again) that you are warned to persist *in* practice and never be content with doing an exercise once or twice. This is because such a warning cannot be repeated too often.

Labour and trouble at the beginning will with the utmost certainty prevent ultimate failure in technique.

Notice Figs. 64 and 66. These are only masses of foliage, but a considerable amount of practice is needful to make the drawing of them at all good. You should aim for an easy, flowing appearance, which will not come at once.

For the purpose of rendering foliage, the continuous line is of no use. Rather, employ broken little lines or mere touches of the pencil. This is the best way of producing an effect of lightness, which is essential to foliage. Hold your pencil vertically and press harder upon it when you are marking in the side of the leaves away from the light, thus producing the necessary effect of shade. The vertical position will enable you to move your pencil hither and thither in any direction you require it to go. A soft pencil such as a "B" will be found the most useful for this purpose.

To throw up the light into relief use short straight lines to begin with as in Fig. 67. This method can also be used for shading as in the later figures. Observe the order of these illustrations, and practise them in turn. Remember always to master the winter appearance of a tree before trying to draw the foliage.

A good plan is to study various types of tree for yourself from nature. Stand before a tree and take stock of its characteristics, the method, so to speak, of its growth and the peculiarities of its bark and branches in winter, its leaves in summer.

Do not neglect to study your subject in detail just because you are advised to cultivate a broad vision of the thing as a whole. One day you might want to draw a branch or a group of small leaves in the minutest detail and then past observation helped by a carefully cultivated memory will be of the very greatest use, even when you have the object in question before you. Then, by drawing what you have observed you will help to keep the details in your memory. The greater time and trouble you take over your drawing, the more tenaciously will the details tend to remain in your mind, ready to be drawn out at future occasions. Learn to compare trees.

Notice that while the bark of the oak and the willow is rough and rugged the beech and birch are smooth and almost silky. Some trees owing to the fact that they are slow in growing have the straight parts of their branches short. The twigs of some trees—the birch, for example—are thin and many in number, also they droop down.

Accurate Knowledge

Ruskin may here be quoted to the point: "The task of the painter," he declares, "in his pursuit of ideal form is to attain accurate knowledge, as far as it may be in his power, of the character, habits and peculiar virtues and duties of every species of being down even to the stone (for there is an ideality of granite and slate and marble); and it is in the utmost and most exalted exhibition of such individual character, order and use that all ideality of art consists.

"The more cautious he is in assigning the right species of moss to its favourite trunk and the right kind of weed to its necessary stone—in marking the definite and characteristic leaf, blossom, seed, fracture, colour, and inward anatomy of everything—the more truly ideal his work becomes. All confusion of species, all careless rendering of character, all unnatural and arbitrary association, is vulgar and unideal in proportion to its degree." J. G. B. L.

"A charming damsel of Marseilles."

"A girl carrying a washing basket."

"A few houses with the hint of a market-place and a bustling crowd."

BOOK ILLUSTRATION.—I

A PLEASANT task which falls to the lot of many artists—frequently early in their career and thus forming the groundwork of their subsequent fame—is the illustration of books.

From a purely pictorial point of view (it is not proposed to deal here with scientific or mechanical illustrations) this work may roughly be divided into three classes: (1) Landscapes, vignettes and thumb-nail sketches for books of travel; (2) illustrations for works of fiction; and (3) illustrations which may or may not be grotesque for children's books.

Of these the first is by far the pleasantest and most grateful task. In making books of travel it often happens that the author acts as his own illustrator: in any case the artist can only be truly successful if he has observed the scenes described at the same time and in the same circumstances as the author.

"With long yellowish-white hair and the most whimsical of faces."

Works of this sort generally include a few coloured illustrations—full-page reproductions of water-colour drawings—whilst the "thumb-nail" sketches in the margin of the text are in pencil or pen and ink. These, it should be observed, are often the best and truest form of illustration. They are but hasty notes—the quick sketch of a woman carrying water, the shadowed alley-way, boats by the river-bank, the fo'c'sle of a sailing ship, a dog in a characteristic attitude—but in such manner the spirit of the book is most likely to be interpreted.

I have before me* as I write an excellent example of illustrated travel book. There are six or eight full-page drawings in sepia and innumerable little sketches in the margins. The big sepia drawings fall far short of the less ambitious work; there is less feeling in them, less life. It is worth while detailing some of the little sketches, however, in order to give an idea of what can be done by sympathy between author and artist.

Restaurant types.

First there is a glimpse of a back street in a little town—just a couple of houses with a hint of a market-place and a bustling crowd; presently we come to the head and shoulders of a woman, watchful-

* *Ways of Escape.* By Douglas Goldring (A. Melrose, Ltd.). By kind permission of the publishers, the illustrations to this article are reproduced from Mr. Goldring's book.

eyed, with chin on hand and a cigarette smoking on a saucer before her—just such a picture as would strike the artist's eye as most certainly attractive and worth a vivid little sketch.

Picturesque Corners

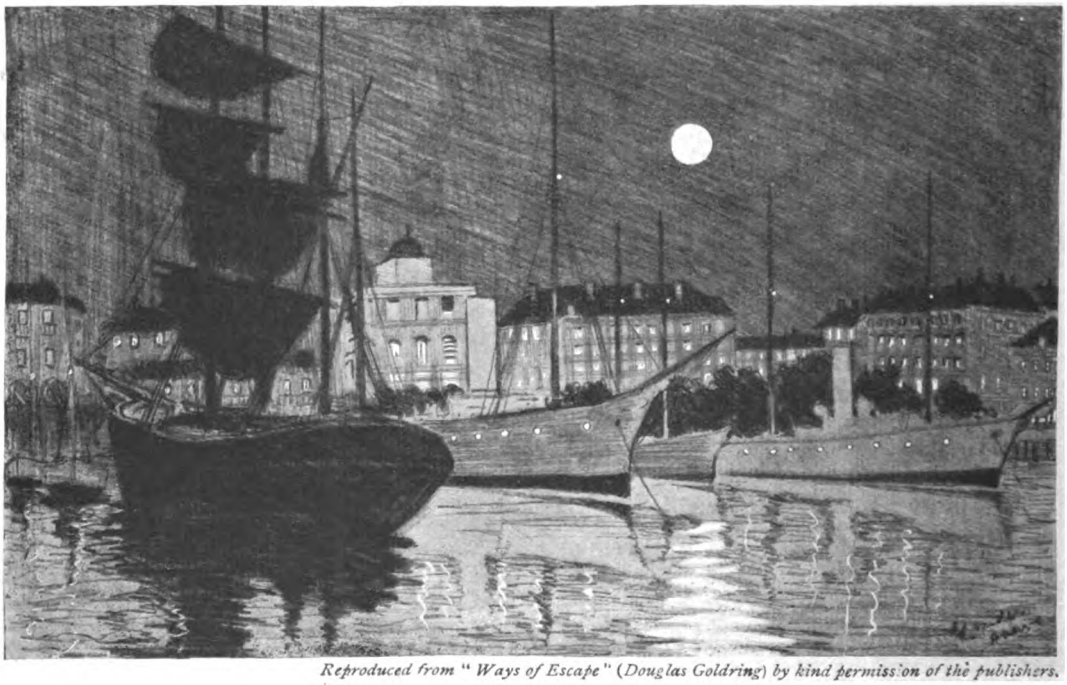
Then there is a tailpiece at the end of a chapter—factory chimneys smoking against a leaden sky. Before long we have a girl drinking coffee at a table, whilst just below her head is repeated, a study, another aspect of her. Further glimpses of towns and villages follow, with here a group of trees and here a group of chimney stacks, and here, again, some heads of men and women and children—a withered old fellow, a laughing boy, pretty girls, old ladies with characteristic head-dress, an old man with long yellowish-white hair and the most whimsical face. The artist shared a bottle of wine with him—all suggested in the drawing. Note the charming damsel of Marseilles glimpsed in passing along a street—just a few lines suffice to express fully the artist's intention in each.

Now we come to a building on a rock, standing against the sunset. This effect is admirably done. The rock rises up with the fewest possible lines below until it merges with gradually increasing shadow to its black summit. Behind there is the least little touch of black denoting a distant hillside towards the west: the top of the sky in the picture is slightly shaded and that is absolutely all: just a little sketch reproduced in a space one and a half inches wide by two long. And yet the flaming ardours of the dying sun simply spring from the white page with its little black lines so economically employed. Next there is a little still-life study—a group of native pottery—and after that, a fountain and a horse with drooping head coming to drink.

A Moonlight Sketch

Here, a suggestion of a rain-swept road in the fewest possible lines makes you almost shudder at its cold and damp appearance, whilst the clouds about a church-tower are obviously hurtling before a tempestuous gale; a girl carrying a washing-basket is followed by a priest carrying his breviary, and a dog sniffing at some offal in the gutter. Some of the little scenes are commonplace and some remarkable, but each has its individual character.

Then, as an example of the larger drawings to which reference has been made, there is the harbour of Le Havre at night, with a vast round moon reflected in the calm water. The lights of the houses in the distance, the masts of the ships, the shadows and the dark ship in the foreground with its sails half furled make a most agreeable and rich impression. J. G. B. L.



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THE BASSIN DU COMMERCE, LE HAVRE.

Continued from page 56.

BUSINESS AND COMMERCE:

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—XVII

In the last lesson we dealt with the routine of handling goods intended for export and described the various forms and documents that have to be prepared to bring a transaction of this nature to completion. We arrived at the point where the goods were on board ship ready to be dispatched; and in this lesson we propose to deal with that most important matter—the question of payment.

In the first place, it is the general rule of shipping that the consignee or purchaser pays all the charges, freightage, insurance, commission, dock fees and so on. In some cases where a shipping agent maintains a steady and regular trade with a buyer abroad the buyer will arrange to keep in this country a deposit account at a banker's, and all the shipping agent needs to do is to present his invoices to the banker in order that his accounts may be settled forthwith. This is the ideal way of doing business from the point of view of the shipper, but such arrangements would only be maintained to meet a constant stream of trade between two houses that were on the best of commercial terms with one another.

Documentary Bills

In other cases the buyers abroad may have agents in this country apart from their bankers, and these agents would give instructions to the shipping merchants, check the quality and quantity of the goods supplied, and when thoroughly satisfied that everything was in order pay the various charges.

In the vast majority of instances, however, the shipping agent obtains his payment through a bank. Having purchased and dispatched the goods the agent would collect the various documents pertaining to the transaction, the bills of lading, insurance policy and invoice, and would take them to a bank having a branch or agency in the country to which the goods have been consigned.

The bankers would then verify and check the various documents and the following day would give a cheque for the amount, less the interest charged for the number of days that must inevitably elapse before the consignee's bank can meet their claim. The documents used in these cases are known as Documentary Bills and the payment of the account in this way is known as Discounting the Bills. It should be noted, however, that the discount is actually paid by the consignee.

Methods of Payment

The next step is for the bank to forward the documents to their agents at the port to which the goods have been consigned, and the agents in due course call upon the consignees to meet the charges incurred and to honour the bills. Then, assuming that the accounts are settled and that everything is in order, the bills of lading are handed over, and when the ship is berthed the goods specified are released in the ordinary way.

And, to give emphasis to this point, it will be well if we point out again the value of the bill of lading as a document representing goods. In our last lesson it was explained that when goods are paid for in the ordinary channels between agent and buyer the bill of lading would be dispatched by post, probably in duplicate, immediately upon the dispatch of the goods. Where goods were paid for direct from a deposit account at a home bank, the bills of lading would be given to the bankers as their security for paying the account. Where bankers pay on documentary bills they also receive the bill of lading, and in cases where the bill of lading is not sent to the purchaser direct it is customary for the shipper to write reporting the dispatch of the goods and mentioning the name of the bank through which the bills have been discounted.

To explain the matter still further and in a broadly popular way: when the shipping merchant goes to the bank to discount the documentary bills it may be said that he pawns or pledges the goods. He cannot deposit the goods because they are on board ship, but no one may obtain the goods without the bill of lading. Therefore the bank accepts as security for its money the document which represents the goods, and the bank's agent does not release the bill of lading until satisfied that the discounted bill will be fully honoured.

But—and there are many " buts " in the world of business and commerce—supposing for a moment that the consignee cannot pay. He may have met with financial disaster whilst the goods have been on the high seas, and have become a bankrupt in the meantime.

Letters of Hypothecation

In such cases as these the whole responsibility lies at the door of the shipper. The consignee cannot obtain the goods from the ship as he does not possess the bill of lading. The bank then, having extended every opportunity for meeting the account, takes possession of the goods by the simple expedient of presenting the bill of lading. Then, in the majority of instances, the bank would sell the goods in the best possible market, and if there was a surplus in money after all charges had been met, this amount would be returned to the shipping agent. On the other hand, there might well be a deficit or shortage, and in this case the shipper would be called upon to meet it from his own pocket.

Naturally, however, the bankers at the port of destination would require some authority for selling the goods, but this contingency is provided for. When the shipping agent presented the documentary bills to be discounted he would also have handed in a Letter of Hypothecation; in other words, an authority to the bankers to sell the goods in the event of their bill being dishonoured by the consignee, or not accepted by him.

Up to the present in these papers on Exports we have assumed that the goods under discussion were being dispatched on a vessel carrying general cargo, of which they would form a part. It must frequently happen, however, that a shipper has such a bulk or quantity of goods to export that he requires for the purpose the use of an entire vessel. In this case he hires or charters a ship to meet his requirements, taking her either by time or for a specified voyage from port to port.

The basis of the transaction is an agreement or contract known as a Charter party, and though it may represent the exchange of many thousands of pounds it only bears a sixpenny contract stamp. This document, like so many other shipping papers, is worded in very quaint phraseology and blank forms may be purchased through all stationers who sell the various forms and papers connected with shipping matters and accountancy.

Briefly, the Charter party contains the names of the two parties to the transaction, i.e. the names of the owners and of the charterers, then follows the name and full description of the vessel, together with the name of her captain. Mention is then made of the time for which the ship is hired, the port from which she is to start and where the voyage is to end, details of the cargo to be carried, the amount payable for her hire, and when it is payable, the given number of days for the loading and discharge of the cargo, and so on. Provision is also made for payment for demurrage at so much per day. Demurrage is the charge made for detaining a boat beyond the time of her charter, either through inability to unload her with promptitude or through a variety of other causes.

Freight and Primage

When a merchant has chartered a vessel he may discover that his own goods are insufficient to supply a full cargo; and in this case he has the right to obtain freight from other merchants to make up the deficiency and to receive payment himself for its carriage.

The charges made for chartering a vessel naturally vary considerably according to the nature of the cargo, number of ports of call and similar matters. In some instances payment is made at so much per ton weight; but frequently the charges are based upon measurement, so much being charged per cubic foot. All charges of this nature are referred to in shipping circles as Freight or Freightage.

When a merchant charters a vessel but fails to occupy her full capacity, the empty space remaining in the holds is referred to as Dead Freight; and in some circumstances a charge is made. Primage, which also enters into a charter party, is the charge made for the use of appliances and tackle for the loading and unloading of a cargo into or from a ship.

A. B.

CHOOSING A CAREER.—XVIII

The Post Office (*Concluded*).—In the last lesson we dealt somewhat exhaustively with that backbone of the Postal Service, from a recruiting point of view, the Boy Messenger; and also with Assistant Postmen, Postmen and male Sorting Clerks.

We come now to that grade known as **Male Learners.** So far as London is concerned, this class is filled almost entirely from the Boy Messenger ranks; but in some of the large provincial centres it is recruited from the general public and examinations are conducted as required by the Civil Service Commissioners, usually once in four months, and advertised in the chief local newspapers. The candidates are lads who have placed their names on a list kept by the local Postmaster, to whom all applications for candidature should be addressed.

Such candidates may only compete in examinations held in their own town and must be at least five feet in height; and of an age to have lately left school. The examination embraces English, History, Geography and Arithmetic, and much stress is laid upon handwriting.

Learners are employed under the same conditions as messengers in the sense that they do not qualify for pensions and are liable to be dispensed with should their attainments not reach the required standard. On appointment as sorting clerk or telegraphist, however, the worker becomes an established employee of the Post Office, with the full benefits of the Service; subject only to one year of probation.

Telephone Labourers, i.e. men who assist in the fixing of lines and instruments, and in the performance of similar duties, are engaged chiefly through the local Labour Exchanges. Incidentally, many of the Boy Messengers receive their appointments through this channel. Hence, when a Post Office berth is desired, it is always a good plan for the applicant to call at the nearest Labour Exchange for information as to where to lodge his application; and what likelihood there is of his services being accepted in the near future.

The Girl Probationer represents in the fair sex the counterpart of the Boy Messenger in the Postal service, and many of the higher ranks of female employment are recruited either largely or solely from this class. So far as London is concerned, candidates should apply to the *Controller, London Telephone Service*, 144*a*, *Queen Victoria Street, E.C.*1, or to a Labour Exchange; in the Provinces, application should be made to the local Postmaster or to the Telephone District Manager. Candidates must have passed Standard VII at school or its equivalent in an educational test; and must live with their parents or with a guardian within reasonable distance of the office in which they wish to be employed.

The prospects of a girl probationer are distinctly good, leading in course of time to positions as Telephonists, Female Clerical Assistants, Female Learners and Sorting Assistants.

Female Learners, Sorting Assistants and Telegraphists represent a large class of postal employees. In London open competitive examinations are held, and applications to attend should be made on the prescribed form to *The Secretary, Civil Service Commission, Burlington Gardens, London, W.*1. Notices of forthcoming examinations appear in certain of the London newspapers, usually on Thursdays.

Candidates for positions as Female Learners must be of the age to have just left school, and be at least five feet in height; the limits of age are usually between 14 and 16. Candidates must satisfy the Civil Service Commissioners as to health and character and the examination embraces the following subjects: English, History, Geography and Arithmetic; whilst particular attention is paid to the candidate's handwriting.

As a rule, the attendance of Learners does not exceed eight hours daily, and when their turn for admission arrives they have to attend the Telegraph School for a part of each day for instruction in telegraphy and also in typewriting. For the rest of the day they will be employed in distributing telegrams in the Central Telegraph Office. They are liable to be called upon to perform Sunday and Telephone duty, and subsequently have to attend at Branch Post Offices to receive instruction and obtain practice in counter duties.

After a trial of one month, or at a later period, a learner who does not display sufficient aptitude for her duties may have her appointment cancelled, and Learnership gives no claim to pension. It is only when Learners are promoted to higher grades that they become established Civil Servants entitled to superannuation.

The duties of female sorting assistants consist principally in sorting and distributing official papers relating to Savings Bank, Postal Order or Money Order business. The limits of age in this class are rather higher and the examination includes as its

subjects reading manuscript, writing, spelling, arithmetic and geography. A number of the vacancies in this class is reserved for limited competition among those who have had at least one year's continuous service in the Post Office on duties occupying not less than three hours daily.

It should be explained that the regulations as to the entry into the Post Office of girls just leaving school vary slightly. There are separate rules that apply to London; others to large Provincial Post Offices; others again to smaller Provincial Post Offices. In each case, however, advice and particulars are obtainable at the local Labour Exchange by making personal application; here also the rates of wages payable may be ascertained.

Female Telephonists are employed in the London Telephone Service and also in the Provincial Post Offices. Candidates must be at least five feet in height without boots, and the age limits are 16 and 25. They must speak clearly, distinctly and grammatically, and their speech must be free from pronounced local dialect. They must have good hearing and sight.

The examination covers the following subjects: reading and copying manuscript, writing, spelling, and arithmetic (first four rules, simple). The appointments are subject to two years' probation, and telephonists are required to work forty-eight hours on week-days; whilst they may be called upon for Sunday duty, for which extra duty payment is given.

Telephonists are required to resign their appointments on marriage. In London application should be made to *The Controller, London Telephone Service*, 144a, *Queen Victoria Street, E.C.*1., or to a Labour Exchange. In the provinces, to the local Postmaster or to a Labour Exchange. Conditions of employment in the provinces are much the same as in the Metropolis, but the rate of wages and hours are slightly different.

Telephone work in London is of course much heavier than in provincial towns. In the very busy hours no little strain is endured by the telephone operators. Patience, sound nerves and an equable temperament are the qualities of which the teleponist stands most in need for successful and efficient work.

Female Typists are employed in the Edinburgh, Dublin and certain provincial Post Offices. Nominations as a rule are confined to those applicants whose names have been noted on a list kept by the local Postal or Telephone Authorities, to whom all applications should be addressed by intending candidates.

The limits of age for the situation are 17 and 21, and the Civil Service Commissioners conduct an examination in writing, spelling, English composition, copying manuscript, arithmetic (first four rules, simple and compound, including English weights and measures and reduction) and typewriting, in which the candidates' efficiency is tested both for speed and accuracy.

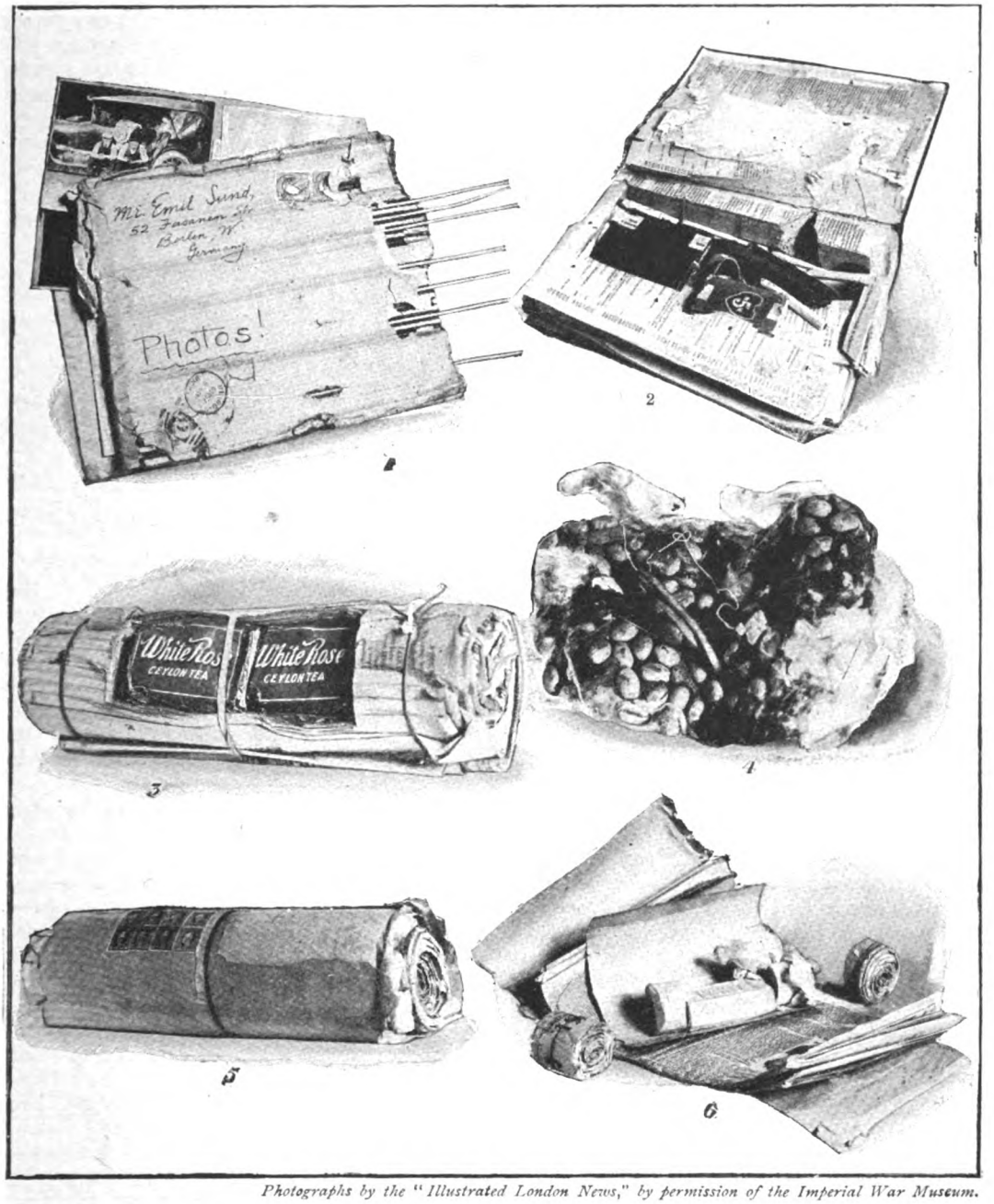
Typists in the General Post Office, London, must be between the age limits of 18 and 30. They, in the candidature stage, are called upon to pass a Civil Service Commissioners' examination in writing, spelling, English composition, copying manuscript, and the first four rules of arithmetic, as well as typewriting. Application for permission to attend the examination must be made in writing to the *Secretary, Civil Service Commission, Burlington Gardens, London, W.*1.

Female Writing Assistants constitute yet another class and are employed in the General Post Office, London. The age limits are 16 and 18 years. The examination is somewhat similar to the one named above, and the girls are employed on minor clerical duties; the weekly wages begin at 18s. rising to as much as 34s. in Dublin and Edinburgh and 36s. in London in certain circumstances.

Many of the **Women Clerks** employed in the General Post Office, London, are drawn from the lists of successful candidates who compete in the Civil Service Commissioners' examinations for this class of worker. Mention was made of this grade in our special lesson on the subject of Women in the Home Civil Service which appeared earlier in this series.

There is also a supplementary establishment of **Clerkships,** in the Secretary's and other offices in the Postal Services. There is a limited competition for the posts among postal officers of not less than two years' continuous full time service in an established or unestablished post. The age limits are 19 to 26 years, and the rates of pay from about £100 to £250 per annum, so that the posts are much sought after by ladies who have already made a start in the postal service.

With regard to female employees, retirement on marriage is almost universally compulsory in the Post Office, but marriage gratuities are given, varying in amount according to the period of service. A. C. M.



Photographs by the "Illustrated London News," by permission of the Imperial War Museum.

SOME WAR TROPHIES OF THE POSTAL CENSOR.

1. An innocent looking package of photographs addressed to Berlin from the U.S.A.: nickel rods were discovered in the corrugated cardboard. 2. Addressed to a prisoner of war: a German directory containing cigars and cigarettes. 3. A roll of newspapers which, when cut open, was found to be full of tea. 4. A consignment of coffee, with rubber adhering to the coffee beans. 5. A roll of Swedish newspapers found to be full of soap. 6. The same roll opened, showing the false ends.

BOOK-KEEPING.—XII

A MERCHANT often finds it profitable to entrust goods to an agent for sale on his behalf. The goods are not sold to the agent; he merely acts for the consignor, to whom he is responsible for the proceeds. His remuneration generally takes the form of a percentage on the sale. Having disposed of the goods, he renders an account to the consignor showing the gross amount realised, giving particulars of charges and expenses incurred.

Consignment Transactions

Consignment transactions are often associated in the minds of students with foreign trade only, but they are not infrequently met with in the home trade. For example, a fruit grower will consign to an agent quantities of fresh fruit which the latter will dispose of in the open market, probably to better advantage than if the grower had personally undertaken the sale to retail dealers.

It is obvious that as the goods are not sold it would be incorrect to treat the transaction in the same way as goods sold. So long as the goods remain unsold in the warehouse of the agent they are the property of the consignor.

Suppose that William Barclay sends to his agent, James Green, in Sierra Leone, goods to the value of £450. If Mr. Barclay has many transactions of this kind he will record them in a special Consignments Outwards Book, but for the sake of clearness the record may be made in the form of a Journal entry, which would be as follows :—

			£	s.	d.	£	s.	d.
Consignment a/c (J. Green)	Dr.		450	–	–			
To Goods on Consignment a/c						450	–	–

Although the goods have gone out and are therefore credited, they have not been sold, and must not be included with the ordinary sales, but kept separately.

Charges for freight, insurance, railway carriage, etc., will probably have to be paid by the consignor. Supposing such expenses amount to £30, the consignor will naturally expect to receive this amount back, as it represents an added value to the goods consigned. The Consignment Account will, therefore, be charged as follows :—

CASH BOOK

	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.
										By consignment charges for freight, etc.				30	–	–			

When the consignment reaches Mr. Green he may remit a banker's draft to the consignor for the sum of £200 on account of the consignment. This is not at the time a part of the proceeds, the goods not yet having been sold, but is in the nature of an advance. The amount will pass through the Cash Book, and be credited to Green's personal account, the entry being as follows :—

CASH BOOK

	£	s.	d.	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.	£	s.	d.
To J. Green				200	–	–													

The fact is that the owner of the goods has simply arranged that part of his stock shall be transferred from his own premises to the care of the agent for the time being.

In the consignor's accounts the transaction will be treated as a consignment outwards. The treatment of such items in the books of account does not present any real difficulty so long as the student bears in mind the exact nature and effect of the transaction.

In the course of time Green will dispose of the goods and send to Barclay full details in the form of an "Account Sales." Assuming that the gross amount realised is £930, and that expenses and commission amount to £127 18s. 3d., the Account Sales will appear as on page 119. First the goods are noted down in detail. The expenses and commission are then subtracted from the amount of the goods, less remitted bill.

ACCOUNT SALES OF GOODS SOLD FOR AND ON BEHALF OF WILLIAM BARCLAY BY THE UNDERSIGNED

Marks.	*No.*	*Description.*	£	*s.*	*d.*	£	*s.*	*d.*
		Goods (give full particulars)				930	–	–
		Less expenses	77	18	3			
		Commission	50	–	–	127	18	3
		Net proceeds				802	1	9
		Less bill remitted on account				200	–	–
						£602	1	9
		E. & O. E.						
		Sierra Leone.						
		J. Green.						

The Journal entries which will record the transaction will be as follows :—

		£	*s.*	*d.*	£	*s.*	*d.*
J. Green,	Dr.	930	–	–			
To Consignment (Gross Proceeds)					930	–	–
Consignment a/c,	Dr.	127	18	3			
To J. Green (Expenses and Commission)					127	18	3

The amount due from Green will therefore be £602 1s. 9d. By a subsequent mail he remits a Sight Draft for £300 and a bill at 2 m/d for the balance, namely £302 1s. 9d. The sight draft will be treated in the same way as a cheque and pass through the Cash Book, whilst the bill will be recorded as a Journal entry, as shown below :—

The goods on consignment having been sold, are transferred to the credit of the Trading Account just as an ordinary sale would be.

CASH BOOK

	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*		£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
To J. Green				300	–	–													

			£	*s.*	*d.*	£	*s.*	*d.*
Bills Receivable	Dr.		302	1	9			
To J. Green						302	1	9

The Ledger accounts affected by the transaction are shown on the next page.

These accounts show that the Consignment Account has been debited with the

		£	*s.*	*d.*	£	*s.*	*d.*
Consignment Account	Dr.	322	1	9			
To Profit and Loss					322	1	9

cost of the goods and all expenses and charges which increase such cost, and that the gross proceeds have been credited. As the proceeds exceed the cost, the difference amounting to £322 1s. 9d. represents a profit, and this amount is transferred to the Profit and Loss Account, the Journal entry being as shown at the bottom of this page.

J. Green has disposed of the goods consigned to him, and has remitted in full the net proceeds, so that his account is closed.

The Bills Receivable Account shows that Barclay has in hand a Bill Receivable for the sum of £302 1s. 9d.

Definitions of Terms

An Account Current is a statement showing the debit and credit transactions between two parties over a stated period. It is practically a copy of the ledger account in the book of the person rendering the account.

It is usual to charge interest on the various debit items and to allow interest on the items credited. The amount representing the balance of interest is debited or credited as the case may be.

An Account Stated is one which shows the balance which has been agreed upon as correct by the parties interested.

CONSIGNMENT ACCOUNT

	£	s.	d.		£	s.	d.
To Goods	450	–	–	By J. Green (Gross Proceeds)	930	–	–
,, Cash (Charges)	30	–	–				
,, J. Green (Expenses)	127	18	3				
,, P. & L. (Profit)	322	1	9				
	£930	–	–		£930	–	–

GOODS ON CONSIGNMENT ACCOUNT

	£	s.	d.		£	s.	d.
To Trading a/c	450	–	–	By Consignment	450	–	–

J. GREEN (SIERRA LEONE)

	£	s.	d.		£	s.	d.
To Consignment (Gross Proceeds)	930	–	–	By Cash (Advance)	200	–	–
				,, Consignment (Expenses, etc.)	127	18	3
				,, Cash	300	–	–
				,, Bill Receivable	302	1	9
	£930	–	–		£930	–	–

BILL RECEIVABLE ACCOUNT

	£	s.	d.		£	s.	d.
To J. Green	302	1	9				

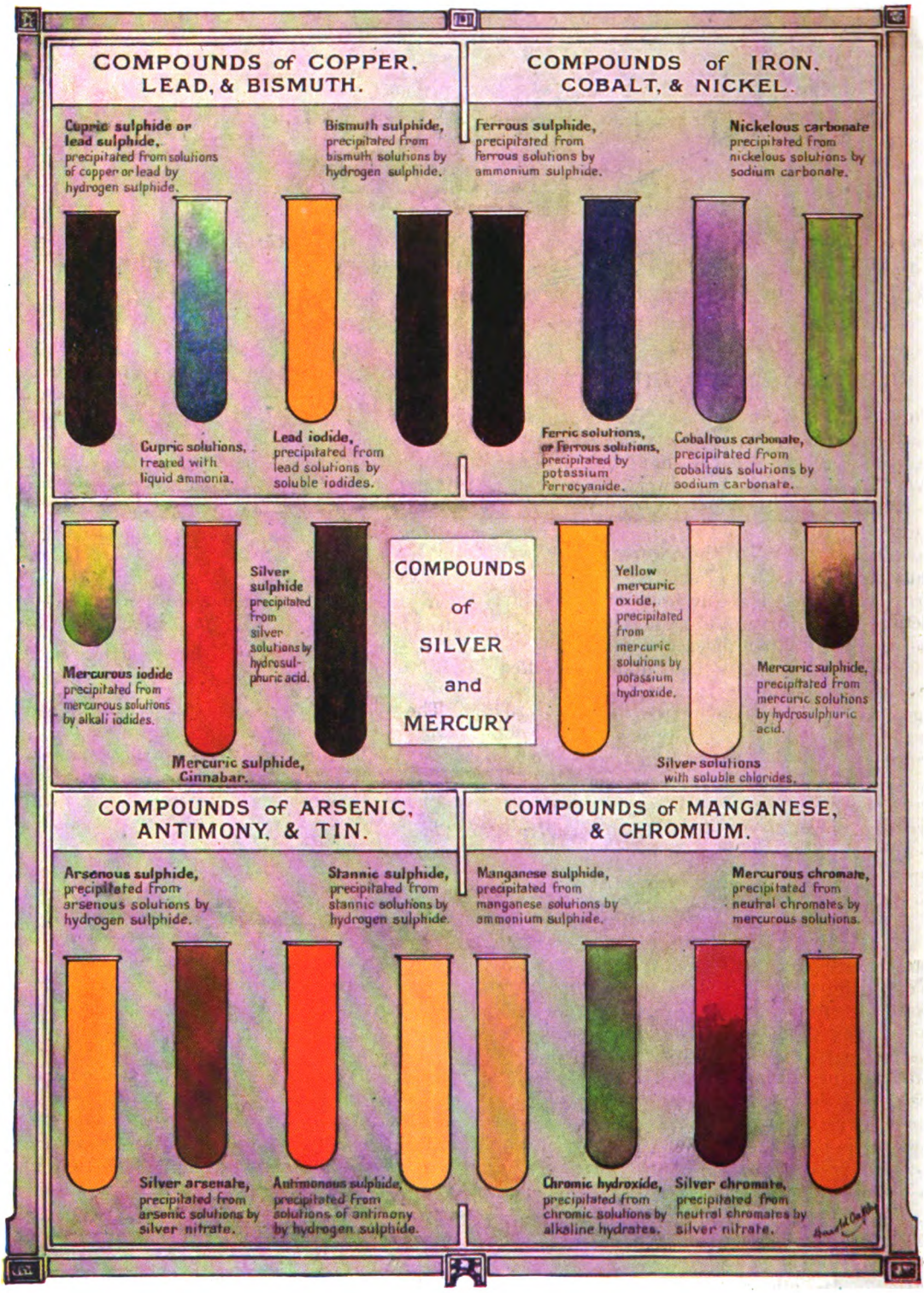
PROFIT AND LOSS ACCOUNT

	£	s.	d.		£	s.	d.
				By Profit on Consignment	322	1	9

TRADING ACCOUNT

	£	s.	d.		£	s.	d.
				By Goods on Consignment	450	–	–

F. H.



SOME CHARACTERISTIC CHEMICAL REACTIONS OF METALS.

Continued from page 62.

ENGLISH LANGUAGE AND LITERATURE:

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THE EARLY JOURNALISTS

THE first forty years of the eighteenth century established English prose in its final form, except, of course, for the slight but constant modifications that must always go on.

By the year 1710 nearly all the special literary features of the period had been developed. By 1740 they were fading away into history. In 1710 Defoe, the first great journalist, and the founder of realistic fiction, aged forty-nine, was known as the most popular of pamphleteers, had been in the pillory, and had begun continuous and effective newspaper work in his *Review*; Swift, aged forty-three, had written thirteen years earlier, and published six years earlier, religious and literary satires which proved that he could wield the most caustic pen that had yet contributed to English prose, and he was writing powerfully on the Tory side in politics and waiting in hungry disappointment for a reward.

The Tatler

Steele, aged thirty-eight, had sown his first crop of wild oats, and was bringing out *The Tatler*, the precursor of literary journalism; Addison, also aged thirty-eight, had published a popular Whig poem, had been rewarded handsomely with office under the State, and was writing for his school-friend Steele the earlier of the miscellaneous essays that have made him for ever famous; Berkeley, only twenty-five, had produced the *Treatise concerning Human Knowledge* that gives him a place among the greatest philosophers.

Finally Pope, the youngest of the great writers then living, aged twenty-two, was already known as an aspiring poet, and had written, though he had not yet published, his rhymed *Essay on Criticism*, which won him a literary standing that was systematically strengthened during the next quarter of a century. But, by 1740, Addison, Steele, and Defoe were dead; Pope, living in affluence gained by his pen, had ceased to write; Swift was insane, and Berkeley a bishop.

The period, brilliant but brief, may be said to start strictly with Defoe's *Review* and Addison's *Campaign* in 1704, and to close with Pope's *Essay on Man* in 1734. Intermediate dates of importance are the publication of Berkeley's *Human Knowledge* in 1710, the *Spectator* in 1711–2, *Robinson Crusoe* in 1719, and *Gulliver's Travels* in 1726.

Daniel Defoe

The writings of the six men just mentioned form the main stream of the literature of what has been fancifully called the "Augustan Age," but there were contributory rills from such writers as Matthew Prior and John Gay; while John Dyer, Allan Ramsay, and James Thomson may be described as detached rivulets that grew into broadening streams. The literary story of the period is the story of the writers we have named.

Daniel Defoe, the true founder of the newspaper and the novel, was born in London, the son of a butcher, in 1661(?). After some training for the Nonconformist ministry he became what he would call a man of "projects"—a tradesman, traveller, and speculator. Had he lived two centuries later he, almost certainly, would have been a millionaire, but in his day the means for realising the dreams of a fertile and practical brain were not attainable. So Defoe did not prosper till he found his true work as a writer, in his forty-third year.

Newspapers had been in existence for about fifty years, but not in such a form as to be treated as a literary asset. It was through the pamphlet that opinion was most readily shaped, and Defoe became the master

pamphleteer of his age. First he caught popular attention by a rhymed outburst, entitled *The True-born Englishman*, in favour of William III. The spirit of it was bold, and the style plain to the simplest intelligence. Defoe was now fairly launched on that "sea of troubles"—politics, and continued its navigation till his death in his seventy-second year.

Unfortunately for his reputation he sought the confidence of both sides by writing for them as occasion offered, though undoubtedly all the while he was a Whig and a Dissenter. His sincerity was specially open to doubt because his humour and satire largely took the form of irony and sardonic exaggeration, which, joined with a marvellous power of seeming real, often deceived, for the moment the dull and prejudiced minds of a narrow and bitter age. It was so in the case of his most famous pamphlet, *The Shortest Way with the Dissenters*. Pretending to be a High Church clergyman, he wrote suggesting the "extinction" of all Dissenters. He would "purge the race of poisoned spirits from off the land."

Robinson Crusoe

So barbarous was the religion of the bigots that at first they gleefully welcomed these sarcastic proposals, and then, on being told that Defoe had been satirising their fury, they turned upon him, burned his pamphlet, and put him in the pillory. But the public, pleased by a poetical address which he wrote to the pillory itself, surrounded it with flowers instead of filth. It was while he was in prison for this offence that Defoe planned, and perhaps started, his *Review*, which eventually became a tri-weekly and, written entirely by himself, was kept up for more than nine years.

The end of the *Review* was marked by a misunderstanding of Defoe's sarcasm as ridiculous as that which disgraced the intelligence of the nation at the beginning. Defoe was imprisoned for writing *Reasons Against the Succession of the House of Hanover*, and similar pamphlets, though his object was to expose the weakness of the arguments against that succession. In the end the people with a sense of humour rescued him before any harm was done to him.

For a number of years (1706–1713) he was engaged in travelling about the country for obscure political purposes, but kept up his writing, and long afterwards, probably till 1726, he was, by means of his continued journalism, a Government agent, or what we should now call political organiser.

In 1719 a new stage in a life of almost unexampled industry began. Defoe, who was then nearly sixty, and had suffered from a touch of paralysis, published *Robinson Crusoe*, one of the world's greatest books. Its instant popularity led to the production of supplementary volumes, with *Further Adventures*, and turned Defoe to fiction in the form of tales and sham Memoirs. Among the tales were *Moll Flanders*, *Roxana*, and *Captain Jack*, and among the Memoirs the invented *Journal of the Plague Year*, *Memoirs of a Cavalier*, and *Captain Singleton*, the latter approaching *Robinson Crusoe* in vividness of interest.

Defoe's range of subjects was extraordinarily wide. His writings included history, British and continental; travel, at home and round the world; crime, in wide variety; psychic phenomena, magic and ghosts; a *Family Instructor*, the *Complete English Tradesman*, and the *Complete English Gentleman*; with valuable studies of commerce and economics, as in his suggestions on banking in the *Essay on Projects*. In short he was the first all-round journalist, with great skill in acquiring and popularising knowledge, to which he added vitality from the reasoning of an acute mind, while as a writer of monologue fiction he had genius that has never been surpassed. Behind nearly all that he wrote the preacher lurked in the background.

A Master of Narrative

Defoe's pen enabled him to live in comfort till nearly the end of his days, though after he had turned seventy he seems to have suffered from family troubles, and to have been living in comparative obscurity when he died in 1731. He was buried in Bunhill Fields, the Nonconformist Valhalla.

The feature of Defoe's writing that makes it immortal is its air of actuality, created by the most simple means. *Robinson Crusoe*, *The Memoirs of a Cavalier*, *Captain Singleton* and *The Journal of the Plague Year* are alike in that respect. Whether he pretended that he was a rabid persecutor, or a plotting Jacobite, he pretended so well that he landed himself in prison, although his object was to damage the cause of the persecutor in the one case, and the cause of the Pretender in the other.

His power of telling a tale just as it might be talked, with the irrelevancies that creep into talk and make it seem fact, amounted to positive genius. Then again he makes no attempt to be complete. If some man who has been brought into a scene drops out of

the story, Defoe is quite content to say that he never heard what happened to him afterwards, and to leave it there, just as we meet people casually, have interesting experiences with them, and part never to hear of them again. Other novelists have built up a sense of life around a plot, as Defoe could not do, but no one has equalled him in interest through plain narration alone.

Jonathan Swift, who was as lucid in his writing as Defoe, and had almost as rare a gift for natural story-telling, with far greater weight of thought and incisive power, was one of the melancholy spectacles of our literature. Essentially a satirist, he descended through disappointment into bitterness of spirit, then deeper into resentment against mankind, and died bereft of reason and consolation.

Swift was born of English parentage in Dublin in 1667, and educated, with William Congreve, at Kilkenny School. Through a distant relationship with Dorothy Osborne, Sir William Temple's wife, he became secretary to Sir William at his home near Farnham. Swift's first books were written while he was in Temple's service, though they were not published till 1704, five years after the diplomatist's death. A friend of Temple, Addison and Steele, Swift was at first a Whig; but naturally he was a Tory, and a supporter of authority in Church and Commonwealth, and, gravitating to that side after Temple's death, he became the most trenchant writer of Tory pamphlets.

At first he had a small Irish living, but spent much time in London, a man of mark in literary and political circles, but exiled when in Ireland. English preferment however never came to him. In 1713 he was made Dean of St. Patrick's, Dublin, and settling down into comparative content became an Irish patriot, a period marked by his *Drapier's Letters* on the currency (1724). The stain of his embitterment can be traced through gradually deepening shades in the several parts of *Gulliver's Travels* (1726) till it turned into disgust at all mankind. He died in 1745 after having been insane for several years.

DANIEL DEFOE (1661 (?)–1731)
This portrait by Van der Gucht is reproduced from the 1710 edition of *Jure Divino*

Interests subsidiary to Swift's literary fame are his friendships with contemporary men of letters, particularly Addison, Steele and Pope, his letters to women, and his interest in the Church. He expected to be made a bishop, and it may be doubted whether that would have satisfied his ambition. But though Swift was nominally an orthodox Churchman, and in many ways the cleverest man in the Church of his day, he had none of the qualities most desirable in bishops. He was essentially non-spiritual, and devoid of broad human sympathies. His genius was critical, disturbing, and destructive. Even in the days of open partisan jobbery it was not felt fitting that he should have high ecclesiastical preferment.

Swift's two earliest works, *Tale of a Tub* and *The Battle of the Books*, published together in a single volume, dealt, in a spirit of satire, with religious controversy, and with the supposed rivalry of ancient and modern writing, the latter subject being one that Sir William Temple had discussed with quite inadequate scholastic resources. All Swift's other writings come to us as miscellanies thrown off in a casual way, except *Gulliver's Travels*, which, under the guise of highly romantic pictures of purely imaginative States, that may be watched artlessly by children, are really pungent satires on all human institutions, and even scornful attacks on human nature itself.

The *Tale of a Tub* satirises the controversies between Anglicans, Catholics and Nonconformists, its title being taken from the alleged custom of seamen, when their ship

From the picture by Eyre Crowe, A.R.A.

DEFOE IN THE PILLORY

at Temple Bar, 31st July, 1703—the punishment meted out to him at the Old Bailey for writing and publishing ***The Shortest Way with the Dissenters.***

is threatened by a whale at sea, tossing a tub to the whale to distract its attention. His book is such a tub thrown to the public. He treated it as a kind of safety-valve in controversial times, but its handling of all religion was irreverently free.

In the *Battle of the Books* the classical and modern books of a library engage in warfare, the ancients, of course, getting the best of the encounter.

Swift had genius unmistakable, but it was bilious and saturnine, and his writing is preserved by its pellucid and powerful style rather than by the intrinsic value of its thought.

In spirit Sir Richard Steele was the opposite of Swift—full of the milk of human kindness, eager to forgive, easy-going and generous, an impulsive Irishman, genial and irresponsible. He must be bracketed with Daniel Defoe as one of the men who first

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SIR RICHARD STEELE (1672–1729).

An impulsive Irishman and one of the first to make the periodical press of England something more than a bald record of events varied with bitter partisanship.

made the periodical press of England something more than a bald record of events varied with bitter partisanship.

Born in Dublin in 1672, he was educated at Charterhouse and Oxford, and both at school and the university was a friend of Addison. From the university he volunteered for the Army, and rose to be a captain. Between 1701 and 1705 he wrote for the stage in a strongly sentimental vein. In 1707 he was appointed editor of the *Gazette*, then, as now, the routine organ for official news.

The *Gazette* gave him no scope as a writer, though he had full command of the news of the day. What was needed was a periodical that would represent the expanding

From the portrait by Sir G. Kneller, by permission of J. Clinton Baker, Esq., Bayfordbury, Herts.

JOSEPH ADDISON (1672–1719).

Precise, finished, artistic in his literary tastes, Addison shared with Steele the enormous success of the *Spectator*.

social life of London, particularly as it was displayed in the coffee-houses.

For this purpose Steele started, in 1709, the *Tatler*. The paper, published three times a week, became quickly popular. It was issued anonymously, Steele assuming as a disguise the name of Isaac Bickerstaff. He was joined later by his friend Addison, whose graceful fancy and chaste style added to the journal's popularity.

The *Tatler* closed down in January, 1711, and two months later *The Spectator* was begun. It continued till December, 1712. In March, 1713, the *Guardian* was started—the last of Steele's periodicals to which Addison contributed. Later, Steele issued other papers in the Whig interest, and, on the accession of the House of Hanover, re-entered Parliament from which he had before been expelled, held lucrative official posts,

was knighted, wrote again successfully for the stage, but finally had to compound with his creditors and retire to the country for retrenchment, and there he died in 1729, aged fifty-eight.

In the *Tatler* and the *Spectator* the fame of Steele and Addison is an interwoven fabric. The natures of the two friends were complementary. Steele was suggestive, dashing, and desultory; Addison was precise, finished, artistic in his literary taste. Steele was the more human, and particularly could touch more truly the chord of pathos. Addison was more elaborate, graceful, complete, and wrote far more frequently up to the level of the literature that endures. But no one can have an intimate knowledge of the writing of Richard Steele without feeling strongly drawn to him as one who, notwithstanding a strain of waywardness, and an incorrigible Bohemian unthriftiness, did much towards bringing into our literature new tones of purity and unaffected tenderness.

Joseph Addison, son of a Wiltshire clergyman who became Dean of Lichfield, was educated at Charterhouse and Oxford, where he gained such repute as a scholar and poet, through academical exercises, that he was allowed £300 a year for travel on the Continent, to prepare for Government service. The pension ceased with the death of William III.

Joseph Addison

After his return home Addison was selected through the influence of Lord Halifax, who had arranged for his travel, to write a poem in commemoration of Marlborough's victory at Blenheim. The poem, *The Campaign*, was a popular success, and as a reward Addison received an official appointment, with more pay than work, vacated by the death of John Locke. This was in 1704, and for the next six years, until the Whig ministry was overthrown, Addison passed from one promotion to another, became a Member of Parliament, and finally secretary to the Lord Lieutenant of Ireland.

Towards the close of this period of official life he began to contribute essays to the *Tatler*, which had been started by his school friend, Steele; and later, when his party was out of office, he co-operated with Steele in *The Spectator* and *The Guardian*, and, in 1714, helped to revive *The Spectator* for six months apart from Steele. During this time of political recess (in 1713) his tragedy *Cato*, written when he was on his travels, was produced with immense success.

With the death of Queen Anne, Addison's friends returned to power, and for three and a half years he resumed official service, becoming finally one of the Secretaries of State, an office he resigned on the plea of ill-health fifteen months before his death in 1719 at the age of forty-seven. He was buried in the Poet's Corner at Westminster Abbey.

Though Addison continued to write occasionally for political publications, during and after his final period of office, he added nothing to the reputation won by his *Spectator* papers. The interest of the last five years of his life is chiefly personal. At the age of forty-four he married the Countess-Dowager of Warwick. About the same time his friend Pope quarrelled violently with him. Previously he had been engaged in hot political strife with Swift; and, later, he was estranged from Steele.

Pope's Attack

Pope's quarrel originated in the publication, by Thomas Tickell, secretary in Addison's office, of a translation of the first book of Homer's *Iliad*, simultaneously with Pope's translation of the first four books of the epic. Addison expressed the opinion that Tickell's translation was the best which had appeared. Unquestionably Tickell's was a more accurate translation than Pope's, for Tickell was a scholar and Pope was not. Pope insisted that Addison was the real translator of Tickell's version, and proceeded to attack him in verse with doubly-distilled venom, verse which he published deliberately, after Addison's death, in his *Epistle to Dr. Arbuthnot*.

Were there one whose fires
True genius kindles, and fair game inspires;
Blest with each talent and each art to please,
And born to write, converse, and live with ease;
Should such a man, too fond to rule alone,
Bear, like the Turk, no brother near his throne;
View him with scornful, yet with jealous eyes,
And hate for arts that caused himself to rise;
Damn with faint praise, assent with civil leer,
And, without sneering, teach the rest to sneer;
Willing to wound, and yet afraid to strike. . . .

Joseph Addison's work on the *Spectator* gave the periodical the sustained thoughtfulness and grace which have made it an English classic. Of the 635 papers published, Addison wrote 274 and Steele 240. The circulation rose as high as 14,000 copies per issue, and the tone of moderation, courtesy, learning, delicacy, and the wide range of human interest had a marked effect on thought and manners. J. D.

THE ENGLISH LANGUAGE.—X

WHATEVER the kind of composition that we are engaged in, be it narrative or description or exposition, the general principles that we have discussed in connection with the paragraph and the sentence hold equally true.

We must realise our whole aim from the first: our composition must have a *plan*, or intelligible method of development; each paragraph most follow logically and naturally from the preceding one, so as to give the whole composition the necessary *unity* and to avoid at once irrelevant digressions and a vague meandering of thought. The student is urged from the commencement to think his subject out before he begins to write.

Prose Composition

As a preliminary exercise, we shall suggest the composition of a number of single sentences which shall aim at making a single simple statement in a concise and rounded manner. If, for example, we wish to give a definition of some object or idea, we can often do it in a single sentence; e.g.:

(i) Evolution is the name given to the process by which the objects seen in Nature, whether animate or inanimate, have by a gradual and unbroken series of changes attained their present form and character.

Such a sentence might well form a unit in a larger whole; for the present, however, we test it by the clearness and precision and accuracy with which it makes us acquainted with the meaning of the word evolution.

A similar exercise, not less useful to the purpose of attaining point and lucidity in sentence-construction, is the expression in condensed form of a single fact or statement dealing with some larger theme; e.g.:

(ii) While most of the scientific discoveries of the past century have turned out to be double-edged gifts to mankind, chloroform has, by the part it has taken in the preservation of life and in the alleviation of suffering, been of unalloyed benefit.

(iii) If man were deprived of the greatest literature of the world, he would lose his most valuable life-companion—his solace in sorrow, his stimulus to great thoughts, and the mainspring of all his best work.

As a help in the concise and effective presentation of thought, a paraphrase is often useful. The thought is then ready-made, and all that we have to do is to recast it in our own diction. Usually a paraphrase involves turning the language of poetry into that of prose. In doing this, our aim should be to simplify the expression without changing its meaning. Hence we must first read the passage until we have mastered the sense, and then rewrite it in the natural language of prose.

By a scientific description, we understand a statement of facts in the simplest and most unadorned style that is consistent with clearness and accuracy. The object is the presentation of facts as facts, for the sake of information; there is no idea of giving pleasure, but the purely utilitarian aim of setting down knowledge in its most available form. Consequently all attempts at the ornate or picturesque should be studiously avoided, e.g.:—

How to develop a photographic plate.

Take two dishes, and in the first mix the developer according to the instructions given with it. In the second pour a sufficient quantity of the prepared "Hypo" solution to cover the plate completely. Take with you into the dark room a bucket full of clean water. Enter the dark room and examine it carefully to see whether it is perfectly light tight; then light the red lamp, and remove the plate from the dark slide. Place the plate into the solution in the first dish, taking care that the liquid covers the whole plate as quickly as possible. Keeping the liquid in gentle motion to and fro, hold the plate near the red lamp and observe the process carefully. Soon you will be able to discern and identify the dark figures appearing on the plate; allow these to develop until they disappear, and the whole plate becomes almost black. Then remove the plate from the solution, wash it well, and place it into the Hypo solution in the second dish to be fixed.

Exercises

1. Write in one sentence a definition of:—A trawler; a biplane; an anæsthetic; the Local Government Board; astrology; gravitation; materialism; a sailor's duty; a cynic; a stoic; heresy; democracy.

2. State clearly one fact about any of the following:—potatoes; alcohol; liquid air; the planet Mars; the sky at night; a tropical river; music; spring flowers; hail; the life in a pond.

3. Express in simple prose the thoughts contained in the following, taking a single sentence for each:—

(*a*) The native hue of resolution
Is sicklied o'er with the pale cast of thought.

(*b*) To-morrow to fresh woods and pastures new.

(*c*) Stiff in opinions, always in the wrong,
Was everything by starts, but nothing long.

4. Write a post card announcing your arrival at the end of a journey.

5. Describe any kind of machine.

6. Explain *one* of the following:—(*a*) how to treat a cut; (*b*) how steel is made; (*c*) how a potato grows; (*d*) how printing is done; or any similar process.

A business letter is a simple form of composition, akin to the foregoing in the demand it makes upon the writer's powers. As regards the body of the letter, it should be as brief as is consistent with exactitude, and composed without flourishes or flowers of any kind. The following points should be noted :—

(1) The address of the writer, accompanied by the date fully given, must be present, and preferably at the right-hand top corner of the letter.

(2) The name and address of the recipient should accompany the letter, on the left-hand side, either before the introduction or at the close of the whole. The latter is, perhaps, most convenient.

(3) The recipient must be addressed in a suitable and accurate style. All indefinite addresses are bad. "Mr. Reeves, South St., Bolton" is an example of a bad address ; it may find the right person, but on the other hand it may not, and in any case it gives unnecessary trouble. But "Mr. J. Reeves, 27, South St., Bolton" is a definite person.

Style of Address

Generally speaking, men in business are addressed as "*Mr.* J. Reeves," or *Messrs.* Reeves Bros., or *Messrs.* Reeves and Co. Occasions often arise, however, when it is desirable to acknowledge the title or dignity of a correspondent. The use of the appendix *Esq.* is common among professional men, and it is wise to employ it, instead of *Mr.*, whenever its omission is likely to attract notice. In formal and official letters, such descriptions as M.P., J.P., M.A., etc., should be given wherever they are entitled to be used. Writing to a friend as a friend, one addresses him as *J. H. Reeves, Esq.* Writing to the same man in his official capacity, one prefers *J. H. Reeves, Esq., M.A.* Special instances in which it is desirable to recognise a gentleman's proper style are seen in :— The Rt. Hon. J. H. Reeves, M.P. ; Mr. Councillor J. H. Reeves ; The Rev. J. H. Reeves, D.D. ; His Worship The Mayor of Bolton ; The Rt. Hon. Viscount Haldane ; etc.

(4) The opening of a formal letter should be "Sir" or "Madam," "Dear Sir" or "Dear Madam," the latter being the less formal of the two. It is unusual to address a person by name unless he is personally well known to the writer. Following this, should come a brief introduction, courteous in tone, so that the matter of the letter is not thrown at the reader too abruptly.

(5) It is equally desirable to close the letter on a courteous note, and in order to do this certain formulas are in general use. In formal communications, "I am, Yours faithfully," meets most requirements ; but we have also such expressions as "Yours truly," which is rather abrupt ; "Yours very truly," which is generally unobjectionable ; "Yours respectfully," which suggests an appeal or favour asked from the recipient ; and "Your obedient servant," which has a highly official flavour. "Yours sincerely," and "Yours very sincerely," are commonly reserved for friendly communications.

Example :

TOWN HALL,
SOUTH STREET,
BOLTON.

J. H. REEVES, ESQ.,
27 South Street,
Bolton.

14th May, 1917.

SIR,—I am in receipt of your letter of the 12th inst., drawing attention to the lighting arrangements in Bury Road and other main thoroughfares of the borough.

The matter was brought before the Highways Committee at their meeting last evening, and I have to inform you that, after a careful discussion of all aspects of the question, the Committee came to the conclusion that any modification of the existing restrictions is at the present time undesirable.—I have the honour to remain,

Your obedient servant,
EDWARD A. GRIFFITHS,
Borough Surveyor.

Exercises

1. Write a letter answering an advertisement in a newspaper.
2. Write a letter of inquiry to a tradesman, concerning goods.
3. Write a letter of apology to the chairman of a meeting which you had promised to attend.
4. Write a letter to a public man, asking for a testimonial.
5. Write an official letter to any public official.
6. Write a letter on behalf of a Disabled Soldiers' Charity.

The personal or friendly letter has been described as the essence of good conversation, and it gives opportunities for many of the finest points of composition. Whether its object be to convey news or to offer an invitation, to give sympathy or to serve as an outlet for the friendly exchange of ideas, its chief merits will be found in its ease and naturalness of style, in its revelation of personality, in its intimate suitability to the recipient. Artificial and stilted diction would be as offensive as incoherent or ungrammatical slang. Many persons who take their private correspondence seriously are read at their best in their letters.

It may be doubted whether, to mention two instances only, the poet Cowper or Robert Louis Stevenson has written anything better than his letters: certainly neither has written anything more charming.

The object of a narrative is to give an account of events as they happened, so that the reader may follow out the incident in his own mind as if he had himself seen it.

At the bottom of this form of composition stands the simple narrative of facts in a bald and unadorned manner, with no other aim than that of giving the bare information asked for or expected. We see examples of this in the succinct accounts given in newspapers of police-court proceedings, in the military reports sent home by our generals at the front, in the minutes of public councils or committees, in the compendious summary of a school-history, and so on. But even in these cases, the writer will generally take advantage of any exceptional circumstance to introduce dramatic details and vivid touches.

Appropriate Style

He wishes his narrative to reawaken the series of events as they occurred, to give their spirit rather than the mere letter—the emotional as well as the historical truth. How different, to choose an example on the large scale, is Carlyle's "French Revolution" from an average historian's presentment of the same facts. When writing a narrative, we must decide first in which form we are going to cast it—whether the literal or the imaginative: the two methods do not blend well, inasmuch as each calls for its own special and distinctive style.

The criticism is often made against Carlyle that it is very difficult to follow the course of events in his "French Revolution," and it is true that the pleasure of his readers is greatly increased if he has the outline of the story in his mind as he reads. Such a criticism applies also to many humbler narratives, and it must always be regarded as a damaging one. Carlyle, however, in his isolated narratives—e.g. of the storming of the Bastille—cannot be surpassed for vividness of imaginative narrative; more useful models of the art are to be found, perhaps, in Scott and, with more heightened emotion, in Dickens. The stories of R. L. Stevenson and Mr. Rudyard Kipling are also in general most admirable examples of the best kind of narrative—admirable alike in their economy of words, in their vividness of effect, in their selection of detail, and in proportion. The student will learn more from the study of such examples than from all the advice that could be given him.

The story is a form of narrative which calls for invention as well as observation. In its simplest form it is a narrative of real or imaginary events designed to impress some special point. Thus an anecdote may be told which throws light upon the character of a well-known man; and in another kind we have the fable, which is designed to bring out some moral truth. In such cases the point should not be made directly, but should be implied in the story itself.

In simple stories in which some sort of moral is to be pointed, the style should be in general as simple as possible, and the introduction of extraneous incidents and descriptions avoided. But stories are most frequently told for the sake of the pleasure and interest they convey—for their own sake, in fact. For such stories the first essential is a plot, i.e. a series of events working up to a climax which is the natural end of the story. In a good plot events must follow one another in an intelligible and natural order; the element of doubt or suspense is desirable in order to excite the reader's attention and interest; the events must be in themselves interesting, but all must be subordinate to the whole, and the reader's mind must not be allowed to wander by the introduction of matter which is irrelevant to the main issue set forth.

Conversation and description, if appropriate to the environment and characters of the story, add variety to the narrative, and may help to keep it in movement—a very important point in a story. Let the outline of the plot be clear in the mind from the beginning, and especially the end and purpose of the whole. Every story has a purpose—not necessarily a moral purpose else it would not be written. A story of adventure has a different purpose from the sentimental romance, let us say. The writer chooses according to his temperament, but he must make clear what he is doing, for his style must be adapted to his theme.

Exercises

1. Write (1) in the form of a simple narrative of the facts, (2) in a more imaginative style, an account of *one* of the following:—(*a*) A railway accident; (*b*) An encounter with a submarine; (*c*) An episode on the battlefield; (*d*) A street riot; (*e*) An air raid; (*f*) A thunderstorm and its consequences.
2. Tell any anecdote with which you are familiar, and in one subsequent sentence explain the point of it.
3. Write the fable of the Dog and the Shadow.
4. Invent a short allegory dealing with the seasons.
5. Invent a short story to point out the evil that may result from inattention to details.

E. W. E.

From the picture by Francisco Pradilla.

BOABDIL, THE MOORISH PRINCE, SURRENDERING TO FERDINAND AND ISABELLA

the keys of Granada, the last Moorish foothold in Spain, 1492. With the expulsion of the Moor and the marriage of Ferdinand of Aragon with Isabella of Castile began the greatness of Spain.

Continued from page 68.

HISTORY:

Contributors:—J. A. Brendon, B.A.(Oxon.), F.R.Hist.S.; F. Collinson, F.R.Hist.S.; T. P. Evans, B.A.(Oxon.); James A. Manson; L. Stampa, M.A.(Oxon.); and J. B. Sterndale-Bennett.

THE BIRTH OF MODERN EUROPE

Out of the turmoil which followed the destruction of the Western Empire, a new order of things was very slowly and very painfully evolved.

To the Romans the State had been as something sacred, to be regarded with the utmost reverence. It had been the same to the Greeks. Such lofty conceptions, however, naturally did not prevail among the semi-civilised warrior communities with which Europe became peopled as a result of the Teutonic invasions. To these folk the State, as an organic institution, meant nothing; monarchy implied little more than chieftainship; whilst the mere suggestion of a republic would have seemed folly incomprehensible.

When the Western Empire fell, therefore, a revulsion towards more primitive conditions became inevitable; and this revulsion, of course, seriously retarded the progress of civilisation. But as the peoples of Europe acquired some degree of culture they grew strongly impressed with the need for a more settled form of government; and the introduction of the feudal system may be said to have been the first effort of this new society to constitute itself.

Decay of Feudalism

Now feudalism was almost as antagonistic to monarchy as to democracy. Side by side with it, moreover, there was growing up in Europe the steadily increasing power of the Papacy, which aimed, as we have seen, at the creation of a spiritual empire co-extensive with the civilised world. Monarchy, therefore, for several centuries had little opportunity of independent growth, being hemmed in on each side by forces stronger than its own—the power of the priesthood on one hand, the power of the nobles on the other; and, although kings constantly contended with the barons and the Church, their struggles met at first with small success.

None the less, the kingly power tended steadily to increase, and that of the great landed proprietors and of the hierarchy steadily to diminish. The Papacy fell into disrepute. The nobles for various reasons —among the, them invention of gunpowder (circ. 1320), which rendered their castles no longer impregnable—were forced to be more amenable. And this, together with the revival of the professional soldier, who enabled the king to dispense in a large measure with the services of his feudal tenants, sounded the death knell of feudalism.

Scientific Government

Royal houses came then to acquire a degree of importance unknown in the Middle Ages. Kings began to regard themselves as a class apart, and continually to increase their power by aggressive wars and family alliances. The notion of a balance of power, and other subtle ideas of international policy, were gradually developed.

In a word, with the growth of commerce, with the revival of art and learning, with the advent of the professional soldier and the politic king, modern Europe came into being.

Even if one condemns as bad the unbridled growth of royal power during the sixteenth century, one must not underrate its value as the initial step out of the reign of feudalism into that of regular and scientific government. The masses, moreover, undoubtedly benefited by the change from the conditions under which they had previously existed.

Under the feudal system, tyranny was elaborately subdivided and, so to speak, brought home to every man's door. The power of some great lord was felt in every village, and by every trembling dependant. His exactions were minute and personal. His will was capricious, and almost unrestrained by law. The larger oppressions of the sovereign, on the other hand, passed over the heads of the humble thousands and fell

almost entirely on the nobles; and it was on this account, incidentally, that resistance to the tyranny of kings was, in the first instance, aristocratic rather than popular.

Spain was the first of the countries of Europe to come into prominence under the new conditions.

In Vol. II. (page 132) we learned how in the eighth century Spain had been overrun by swarms of fanatical Mohammedans, eager to conquer new territories for their faith. These men crossed over into Europe from Morocco, and the Moorish power in Spain reached its zenith in the tenth century. Christian rule, however, still continued among the mountains in the north, and quite early in the eleventh century several Christian kingdoms—notably Aragon and Castile—came into being, and began to wage war relentlessly against the Moorish settlers.

Expulsion of the Moors

At first the Christians made little headway. But gradually the Moors were driven farther and farther southward, until by the middle of the thirteenth century Granada was the only province still under their rule. Here, however, in the fairest of all the provinces of Spain, the Moors held out for two more centuries.

Indeed, it was not until the latter part of the fifteenth century, when the Christian power in the country was united by the marriage of Ferdinand of Aragon and Isabella of Castile, that they were driven from the last of their strongholds. In 1492 the city of Granada itself fell into the hands of the Christians, Boabdil, the Moorish prince, surrendering its keys into the hands of Ferdinand; and with the fall of Granada the domination of the Moor in Europe disappeared for ever.

Then also the greatness of Spain began.

The expulsion of the Moors from Spain, where they had maintained themselves for nearly eight centuries, was an event of great importance in the history of Christendom—the more so in that it to some extent counterbalanced the effects of the capture of Constantinople by the Turks (1453). Yet a contemporaneous adventure, which resulted in the spreading of the faith of Europe over a quarter of the globe till then unknown, had consequences even greater.

To the nations of the mediæval world no less than to the nations of the ancient world, the Atlantic was a mystery—an illimitable waste of water, leading, perhaps (so thought the ancient philosophers), to the shadowy regions of the dead or to some cloud region where the sun went to rest.

In course of time, however, the minds of men became obsessed with the idea of a great continent lying somewhere across that ocean, somewhere to the west of Africa and Europe; and with the dawning of the fifteenth century—an age of awakened vigour, of daring hopes and romantic enterprise—many eyes turned towards the Atlantic, eager to solve its mysteries. The Europe of that time, in fact, was possessed with a passion for discovery; and, so far as concerned the wish to explore unknown seas, the discovery in 1403 of the polarity of the magnet, and its application to the mariner's compass, simplified enormously the difficulties of navigation.

The Portuguese were the pioneers in this work of exploration.

The reign of King John I. of Portugal (1358–1433) was distinguished by many daring voyages. In 1419 the Portuguese discovered and colonised Madeira. Subsequently they acquired Cape Blanco, Cape Verde, the Senegal, the Azores, Sierra Leone, and Benin; whilst in 1486 the intrepid Bartholomew Diaz sailed so far south as the Cape of Good Hope.

These brilliant achievements, which cast an enduring light on the annals of the Portuguese race, served undoubtedly to stimulate the genius and aspirations of the greatest—or at any rate the most famous—explorer of that age, Christopher Columbus.

Christopher Columbus

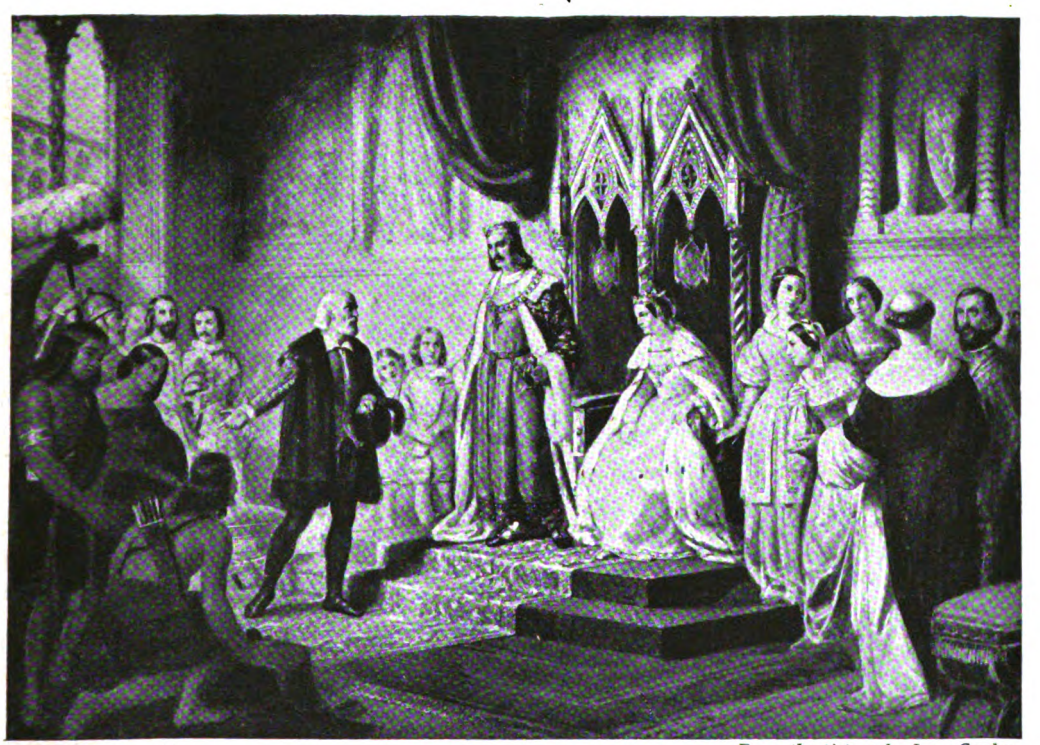
Columbus was a native of Genoa, in Italy, and was born some time between 1436 and 1446. His tastes were always towards geography and astronomy, and in order to gratify them he chose to adopt the profession of the sea, for he, too, was convinced that beyond the waters of the Atlantic lay a country which might be reached by one daring enough to make the attempt.

This country he considered necessary to the equilibrium of the world, as a counterpoise to the eastern hemisphere. He believed, however, that it was simply a prolongation of the shores of Asia, and the outlying portions of America, when at length discovered, were for this reason called the West Indies.

Eager to explore the unknown west, Columbus set about to find the financial support necessary to his enterprise. This proved no easy task. He submitted his great scheme to the Portuguese, to his own countrymen of Genoa, to the Venetians, to Henry VII.

From the picture by R. Balaca.

Columbus taking leave of the Prior of the Convent of Rabida before setting sail (Aug. 3, 1492) for the unknown world.



From the picture by Juan Cordero.

Ferdinand and Isabella receiving Columbus, whose voyages of discovery opened to Spain the coffers of Mexico and Peru, which proved at once the basis of the country's greatness and her ruin.

of England, and to Charles VIII. of France, but for several years failed to rouse any practicable interest in it anywhere. Then at last—thanks mainly to the generosity of the Spanish queen—Ferdinand and Isabella offered him the help which he required.

On August 3, 1492—the year that saw Granada reconquered—Columbus set sail from Palos in Andalusia, and on October 11, after a memorable voyage, sighted land across the Atlantic. The land in question proved to be the islands in the Gulf of Mexico; and Hayti, or Hispaniola (New Spain), as Columbus called it, was the island which the great explorer first touched.

It was not until 1498 that Columbus landed on the mainland of the continent; but in the meanwhile Sebastian Cabot, a Venetian in the service of King Henry VII. of England, had hoisted the English flag in North America. Columbus, therefore, technically was not the discoverer of America. Nor did he even give the continent its name, the name America being derived from that of Amerigo Vespucci, a Florentine seaman, who journeyed across the Atlantic in 1499.

American Gold

Vespucci, however, was also in the service of Ferdinand and Isabella. So it came about that, during the sixteenth and seventeenth centuries, it was into the coffers of Spain that the gold of Peru and Mexico was poured.

When the Moors conquered Spain, the treatment which they meted out to the inhabitants of the country may have been harsh and cruel, but it was mild in comparison with that by which, in 1519, the Spaniards under Hernando Cortez destroyed the wonderful civilisation of ancient Mexico, or to the barbarism of Francisco Pizarro in Peru (1532–6). The one idea of the Spanish conquerors was to acquire gold—that gold which, for a while, made Spain the richest and most powerful country in the world, but which ultimately ruined her.

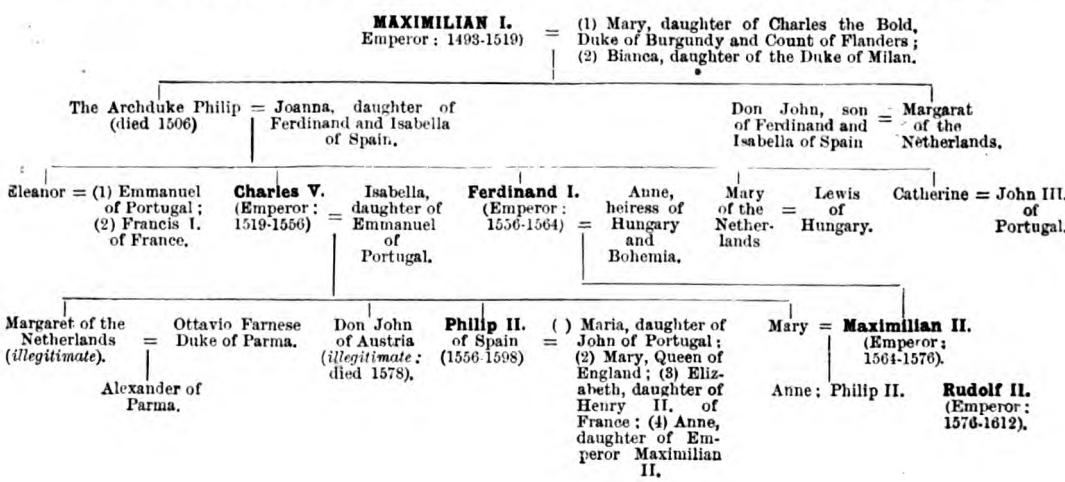
With gold from the New World pouring into its towns and villages, the natural resources of the country were allowed to fall into a state of utter neglect. To make matters worse, moreover, Ferdinand and Isabella, in some respects the most enlightened rulers of their age, committed the fatal error of re-establishing the Court of the Inquisition.

The Spanish Inquisition

The brutal methods—too well-known to need mention here—by which the Inquisition enforced conformity with the doctrines of the Roman Church, rendered it almost impossible either for Jews or Moors to live in Spain, much less to carry on their business. Now, between them, the Jews and the Moors held practically a monopoly of the manufactories of Spain. When, therefore—as happened during the sixteenth century—they were expelled from the country, industrial life came literally to a standstill.

Gold from America and powerful foreign alliances—these were the foundations on which Ferdinand sought to build his kingdom's greatness. His military exploits were not very numerous. But in 1512 he conquered Navarre, thus uniting the whole peninsula, with the exception of Portugal, under his rule; he also secured possession of Sardinia and Sicily; and in 1504, by none

THE HOUSE OF HAPSBURG IN THE SIXTEENTH CENTURY



too honourable methods, added the kingdom of Naples to his dominions.

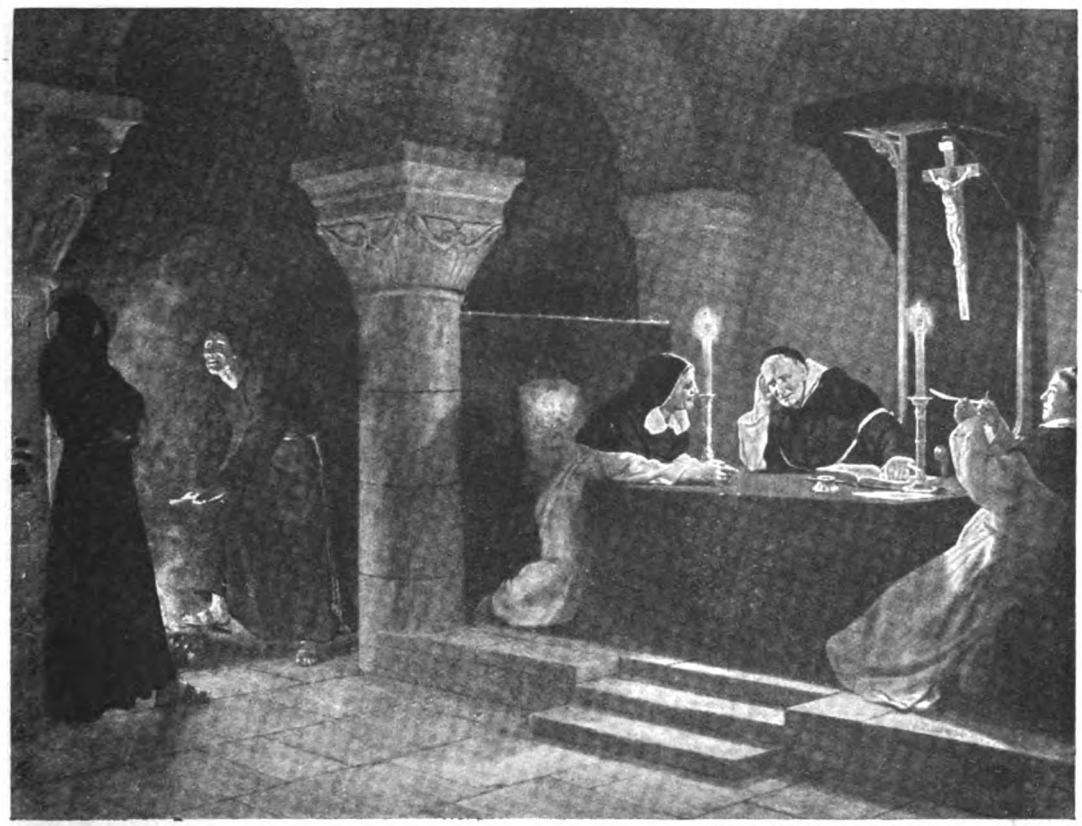
The matrimonial arrangements which he made for his family are of greater importance. In 1495 he entered into an agreement with the House of Austria to the effect that his son, Don John, Prince of Asturias, should marry Margaret, daughter of the Emperor Maximilian I., and that the latter's son, the Archduke Philip—who in right of his mother was also heir to the Netherlands—should marry Don John's sister Joanna.

Don John lived for only six months after his union to the Princess Margaret; and not much better fortune attended the marriage of Isabella, Ferdinand's elder daughter, with Manuel, King of Portugal. She died one year after marriage, and her child died two years later. Thus Joanna, wife of the Archduke Philip, became sole heir of all the Spanish dominions, whilst her husband was heir to those of Austria and of the Netherlands. It is important to bear these facts in mind for reasons which will become apparent later.

* * * * *

The Emperor Maximilian I., father of the Archduke Philip, belonged to the Austrian House of Hapsburg, and was a descendant of that Rudolf of Hapsburg who became King of Germany—he was never formally crowned Emperor—on the fall of the Hohenstaufen dynasty.

Rudolf reigned from 1273 to 1291, and although his descendants did not succeed for some generations in making the Imperial title hereditary in the family, the House of Hapsburg steadily increased in power, and from the middle of the fifteenth century until the fiction of the Holy Roman Empire

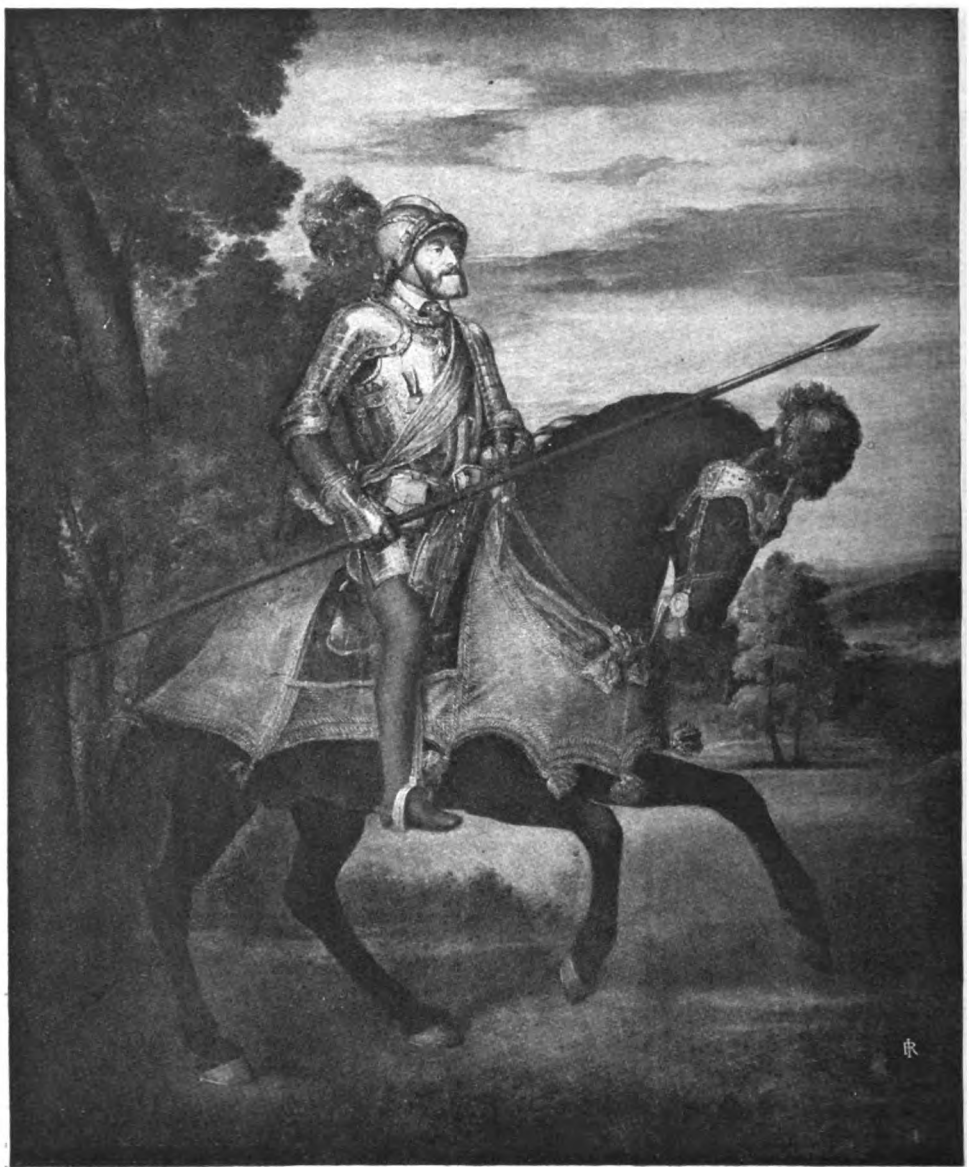


From the painting by the Hon. John Collier.

THE SPANISH INQUISITION: AWAITING THE ACCUSED.

The brutal methods by which the Inquisition Courts, established by Ferdinand and Isabella, enforced conformity with the doctrines of the Roman Church, made it impossible for a Jew or Moor to live in Spain and so killed those industries—a Moorish or Jewish monopoly—upon which the real wealth of the country depended.

was finally swept away, all the Emperors save two were Hapsburgs. In 1806, moreover, when the Emperor Francis II. renounced the title Emperor of Rome and dominions rather than of trying to reform or consolidate his empire. The result was that Germany became more and more disunited; and the Holy Roman Empire,



From the painting by Titian in the Gall. del Prado, Madrid: photo, Anderson.

THE EMPEROR CHARLES V.,

who inherited an empire without parallel in the history of the world; it included Austria, Germany, Spain, the Netherlands, a large part of Italy, and the vast Spanish Empire in America.

King of Germany, as Emperor of Austria, he still remained a great monarch.

Maximilian I., who became Emperor in 1493, inherited the fatal tendency of wishing to extend the boundaries of his family which—to use the inimitable description of Voltaire—had already ceased to be holy, or Roman, or an empire—broke up into a number of semi-independent cities and states.

Like his predecessors, moreover, Maxi-

milian allowed himself to be drawn into the vortex of Italian politics. Here his activities immediately clashed with those of France and Spain.

The rise of the French monarchy to a position of high importance in Europe was largely the work of Louis XI., who died in 1483. His successor, Charles VIII. (1483–98), may not have been a practical statesman of the same calibre, but he was equally ambitious, and soon after his accession advanced into Italy at the head of an army to assert a shadowy claim, which he inherited from his father, to the kingdom of Naples, then in the possession of the House of Aragon.

The Italian states made no attempt to offer a united resistance to the invader. On the contrary, some of them—notably Florence, whose affairs at that time were controlled by a fervid Dominican friar, the famous Savonarola—actually encouraged Charles to come.

Savonarola, one of the most remarkable characters of those times, had for some time past been carrying on a stern crusade against the depravity and incompetence of the Romish priests; and though he did not assume the position held by subsequent German theologians, was generally regarded as an enthusiastic religious reformer. He also believed himself to be a prophet; and since he had repeatedly foretold the invasion of a foreign army which should purge Italy of her sins, the Italian campaign of Charles VIII. was not unnaturally regarded by the Florentines as the fulfilment of these gloomy forebodings.

The Pope, however, Alexander VI., a member of the infamous Spanish House of Borgia, was greatly alarmed by the threat of a French invasion, and, despite his position as head of the Christian Church, went even so far as to appeal to the Turks to co-operate with him in resisting it. These negotiations were still proceeding when Charles entered Italy. The Pope, therefore, tried to temporise, but without success; the French king duly occupied Naples.

Then, however, finding himself confronted by a formidable league, he deemed a return to France imperative. This, thanks to his military skill, he managed to accomplish.

Three years later Charles VIII. died. But his successor, Louis XII. (1498–1515), continued these Italian adventures, and having overrun Milan, led a French army again into Naples, where eventually he came to secret arrangement with Ferdinand of Spain for the partition of the kingdom. Subsequently, however, Ferdinand and Louis quarrelled, and the former, as we have seen, succeeded in making himself master of the whole of Naples. In 1513, moreover, the French were driven from Milan. The Italian policy of Louis ended, therefore, in apparent failure. None the less, these wars are of great historical importance. In the first place, they mark the beginning of a long rivalry—a rivalry which lasted right down to the nineteenth century—for supremacy in Italy between the crown of France and the House of Hapsburg. In the second place, these wars brought the nobility of France into contact with the wonderful civilisation of the South—for Italy, it must be remembered, though a cockpit of Europe, still retained her artistic and intellectual pre-eminence—and so taught the lesson which enabled them soon to make Paris the most brilliant of all capitals.

From the painting in the National Gallery (Tuscan School).

GIROLAMO SAVONAROLA (1452–98), **the great Florentine reformer, one of the most remarkable characters of the fifteenth century.**

In 1515 Louis XII. died, and since he had no male issue, the French crown passed to his cousin, the Duke of Valois, who assumed the title Francis I. This king was only twenty years of age when he ascended the throne. But, being a young man of many accomplishments, with a keen thirst for military glory, he determined immediately to adopt a policy of vigorous aggression in Italy.

A short but brilliantly conducted campaign made him master of Milan, and in the early

part of 1516 he returned to France in triumph. But he left behind him in Italy a host of jealous feelings, and these soon found expression in the designs of the Emperor and of the King of Spain, who, in conjunction with Henry VIII. of England, formed an alliance against him. Happily for Francis, however, this hostile scheme was brought to naught, for in the spring of 1516 Ferdinand of Spain died, and in consequence of this the outbreak of hostilities had to be postponed.

When Ferdinand expired, his grandson the Archduke Charles, heir both to the Spanish and Austrian dominions, was a lad in his sixteenth year. Born at Ghent in February, 1500, he had been brought up entirely in the Netherlands; and at the time of his grandfather's death, neither had he been in Spain nor could he speak the Spanish language. In fact, notwithstanding his maternal descent, he was as little a Spaniard as any other native of the Low Countries.

Yet, despite this, he was immediately proclaimed king under the nominal regency of his mother. But the latter, having become insane after the death of her husband in 1506, was quite unable to take any part in public life. Pending Charles' arrival, therefore, the management of affairs rested in the hands of Cardinal Ximenes, the late king's most trusted adviser; and it was due in no small measure to the latter's loyalty and statesmanship that the new king was allowed ever to enjoy his heritage.

Charles V.

His accession, in fact, met with much opposition from the native Spaniards, and at one time it seemed doubtful if even Ximenes would be able to save for him his throne.

But to the Spanish people—as, indeed, to most nations of that period—hereditary right was a very strong claim on loyalty. Gradually, therefore, if sullenly, the Spaniards rallied round their new sovereign, who before long found himself the greatest prince in Europe.

On January 12, 1519, the Emperor Maximilian died, and Charles, as his grandson and heir, became possessed of the Austrian Archduchy, in addition to Spain and the vast Spanish Empire in America.

Now for some time past Maximilian had been striving to secure for his grandson the Imperial crown. The negotiations, however, were still very incomplete at the time of his death; and after that event two candidates for the vacant honour, besides the King of Spain, came forward to urge their claims.

These were the sovereigns of France and England. Of the two, Francis I. had the better chance; but the claims of neither called for any serious consideration by comparison with those of Charles.

The Imperial dignity had so long gone with the Austrian dominions that many people had come to regard the Empire as belonging by hereditary right to the House of Hapsburg. Moreover, the King of Spain was better fitted, by virtue of his position as an Austrian prince, to resist aggression on the part of the Turks, who were still a constant menace to Central Europe.

So it came about that in 1519, although it was feared in some quarters that the concerns of Spain would absorb the greater part of his attention and that those of the Empire would suffer in consequence, the young Fleming was duly elected and ascended the Imperial throne as Charles V.

A Vast Empire

Ferdinand and Maximilian had achieved by their marriage schemes a result almost beyond the bounds of possibility, for, thanks to their machinations, they had united, under the control of their heir, a dominion of vast extent and of immense resources, an empire without parallel in the history of the world. It included not only Austria, Germany, and Spain, but also the Netherlands, and a large part of Italy and of America. Within its borders, moreover, lay the great cities of Vienna and Brussels, Madrid, Palermo, Naples, and even Mexico, the great city of the New World.

Not even had Charlemagne dreamed of a realm so vast.

At first Charles V. and his most serious rival, the King of France, tried to keep on friendly terms, but anything in the shape of a permanent friendship between the two monarchs was impossible. In the first place, Francis could never forget the pang of jealousy he felt when Charles was elected Emperor. Francis had coveted that title dearly; and the mere fact that his dominions lay wedged between those of the Hapsburg served always to keep alive the flame of his resentment. In the second place, both monarchs aspired to great possessions in Italy; and in Italy, ever an irresistible magnet for the aspirations of ambitious princes, the two monarchs, despite their good resolves of friendship, fought and intrigued through out their reigns.

J. A. B.

Continued from page 80

SCIENCES:

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CHEMISTRY.—XIX

Acids, Bases, Salts.—In the course of our studies we have already become acquainted with a number of acids, all of which, we have learnt, are characterised by a sour taste and by the power of turning litmus red. Sourness in nature is always associated with the presence of acid; thus limes and lemons contain citric acid, unripe apples owe their sour taste to malic acid, and if the grapes that the fox thought to be sour were really unripe, they contained tartaric acid. There are, however, other and more important characteristics of acids, viz., they all contain hydrogen, and they all react with bases to form compounds called "salts." When zinc was dissolved in dilute sulphuric acid to make hydrogen, the latter was displaced from the acid by the metal, and the metal formed a "salt" called zinc sulphate with the residual part of the acid. Although all acids do not react with all metals in this way, nevertheless every acid will react, under suitable conditions, with magnesium to produce hydrogen and a magnesium salt. *A salt may therefore be defined as a compound formed from an acid by the displacement of its hydrogen by a metal.*

Experiment LV.—*To illustrate the formation of salts by the interaction of an acid with a metal. To prepare crystals of lead nitrate, $Pb(NO_3)_2$ from lead and nitric acid.*

About 3·5 grms. of lead foil are cut into small pieces and placed in a 300 c.c. conical flask, and then well covered with nitric acid diluted with at least its own bulk of water. The flask and contents are heated gently on a tripod-stand covered with wire-gauze and a small funnel is placed in the neck of the flask in order to prevent too much liquid being lost by evaporation. The metal dissolves slowly, brownish-red fumes are evolved, and if the acid be kept dilute no separation of lead nitrate occurs.

If the acid be too strong, the action will soon cease, because the white crystalline salt being insoluble in concentrated nitric acid will separate out, coat the metal, and so protect it from dissolution. When complete solution has been effected, the clear liquid should be poured off into an evaporating dish, concentrated by evaporation if necessary, and then set aside to crystallise. If acid-free crystals are required, an excess of lead must be used, and the product should be washed once or twice with a little cold distilled water. The main reaction which occurs is probably: $3Pb+8HNO_3=2NO+3Pb(NO_3)_2+4H_2O$.

Production of Salts from Metallic Oxides and Acids.—The hydrogen of an acid can also be dispaced by a metal if the latter is in combination with oxygen as an oxide. Very many metallic oxides react with acids to form salts and water only; thus cupric oxide and hydrochloric acid form cupric chloride and water, $CuO+2HCl=CuCl_2+H_2O$. Similarly $CuO+H_2SO_4=CuSO_4+H_2O$ and $CuO+2HNO_3=Cu(NO_3)_2+H_2O$ (and see Experiment XLI.). This type of reaction affords a very valuable method of preparing salts.

Experiment LVI.—*To prepare crystallised copper sulphate from copper oxide and dilute sulphuric acid.*

About 25 c.c. of dilute sulphuric acid are gently warmed in a porcelain dish, and small quantities of copper oxide are added from time to time, until all action has ceased. The liquid is poured through a filter and allowed to cool.

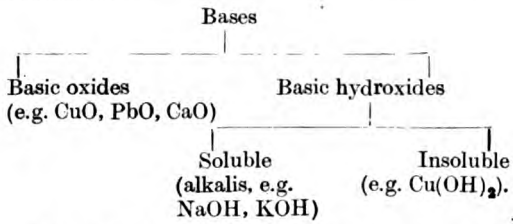
The dilute sulphuric acid should be kept dilute and an excess of copper oxide should be used. Instead of crystallising at once to obtain moderately large crystals of copper sulphate, a purer product is obtained by making very small crystals first, filtering and washing these, and then recrystallising from a weaker solution. The small crystals, which are much more readily washed, are made by cooling a hot concentrated solution quickly by standing the containing vessel in cold water, and at the same time stirring vigorously the cooling liquid with a glass rod.

Experiment LVII.—*To prepare potassium nitrate from caustic potash and nitric acid.*

Some diluted nitric acid is put in a dish and caustic potash solution is added gradually: heat is evolved. To ascertain when the alkali has "killed" or

" neutralised " the acid, drops of the liquid may be transferred on to red and blue litmus papers; when the neutralisation is complete the liquid will turn neither blue litmus red, nor red litmus blue. If it be found difficult to get the neutral point, one or both of the solutions may be considerably diluted. The neutral liquid is concentrated by evaporation and then crystallised. $KOH + HNO_3 = KNO_3 + H_2O$.

Although the expression " to neutralise " is most often applied to the interaction of alkalis and acids, yet it is equally applicable to the changes which take place when an acid is caused to lose its characteristic properties by bringing a metal, a metallic oxide, an insoluble hydroxide, or other substances in contact with it. Of all the kinds of substances which give salts with acids, only two yield a salt and water *only*; these are the hydroxides and (many of) the oxides of metals, and the term *base* is used to designate them. *A base, then, is a substance which reacts with an acid to form a salt and water only.* Bases are subdivided as follows:



A salt is named after the acid from which it is derived, thus a salt of hydrochloric acid is called a chloride, a salt of nitric acid a nitrate, and so on. The termination —ide always signifies a compound containing two elements only; —ate expresses the fact that the compound contains oxygen, i.e. is derived from an oxy-acid like nitric acid HNO_3, chloric acid $HClO_3$: —ite also signifies a salt of an oxy-acid, but one which contains in its molecule one atom of oxygen less than the salt with the ending —ate, sodium nitrite $NaNO_2$—sodium nitrate $NaNO_3$. It will be remarked that the acid terminations —ic and —ous correspond with the salt terminations, —ate and —ite.

Chlorides may be prepared by the methods already given; in addition, many can be made by direct combination of a metal with chlorine, the insoluble chlorides are obtainable by precipitation, and all can be made by acting upon a carbonate (a salt of carbonic acid, H_2CO_3) with hydrochloric acid.

Experiment LVIII.—*Isolation of Chlorides.*

(i) To solutions of lead, mercury (mercurous) and silver nitrates, add some hydrochloric acid or the solution of any soluble chloride, e.g. NaCl. White precipitates of lead; mercurous and silver chlorides are obtained, which differ but slightly in appearance; silver chloride is dissolved by ammonium hydroxide, mercurous chloride is blackened by it, and lead chloride is unaffected. The last-named, however, is the only one of the three which dissolves in boiling water.

$Pb(NO_3)_2 + 2HCl = PbCl_2 + 2HNO_3$.
$HgNO_3 + HCl = HgCl + HNO_3$.
$AgNO_3 + NaCl = AgCl + NaNO_3$.

(ii) Dissolve some marble (calcium carbonate) in hydrochloric acid and evaporate to dryness; a white earthy solid, calcium chloride—$CaCl_2$, is left.

Tests.—(iii) Solutions of chlorides may be detected by means of the silver nitrate reaction, e.g., $NaCl + AgNO_3 = AgCl + NaNO_3$; the precipitate is soluble in ammonia but insoluble in nitric acid.

(iv) Solid chlorides, with but very few exceptions, evolve hydrogen chloride when treated with sulphuric acid (cf. common salt).

(v) A solid chloride and manganese dioxide and sulphuric acid give, on warming, chlorine gas, recognised by its smell, colour and action on moist litmus paper. $2NaCl + MnO_2 + 3H_2SO_4 = Cl_2 + MnSO_4 + 2NaHSO_4 + 2H_2O$.

Nitrates are obtainable by the action of nitric acid upon most metals, and upon all bases and carbonates. As they are all soluble in water, they cannot be made by precipitation.

Experiment LIX.—*Tests for Nitrates.*

(i) When heated in a small hard-glass tube nitrates are decomposed giving nitrogen peroxide and oxygen, and leaving the oxide of the metal as residue (cf. lead nitrate, Experiment XLIX.). The exceptions to this rule are the nitrates of sodium, potassium and ammonium.

(ii) On warming with sulphuric acid, every nitrate produces fumes of nitric acid and if a little indigo solution be added, it will be bleached.

(iii) Warmed with sulphuric acid in presence of copper, nitrates yield nitrogen peroxide and a bluish green solution of copper nitrate.

(iv) To a dilute solution of a nitrate, add some ferrous sulphate solution, cool the liquid under a running tap, and cautiously add sulphuric acid. If the liquid be cold, a brown ring ($2FeSO_4$, NO) is formed at the junction of the two liquids.

The Basicity of Acids.—We will now give the formulæ of some of the more common acids, arranging them in classes according to the number of hydrogen atoms their molecules contain.

I.	II.	III.
HCl	H_2SO_4	H_3PO_4
HNO_3	H_2CO_3	(ortho-phosphoric acid)
HNO_2	H_2SO_3	

The acids in class I. all contain one atom only of hydrogen which can be displaced by a metal; they are called monobasic. Those in class II. contain two replaceable hydrogen atoms: they are called dibasic. Phosphoric acid contains three such atoms and is termed tribasic. Monobasic acids yield only one sodium salt, e.g., there is only one sodium chloride, NaCl; dibasic acids give two distinct sodium salts, e.g., there are two sodium salts, normal sodium sulphate (which is neutral to litmus) Na_2SO_4, and sodium hydrogen sulphate (acid to litmus) $NaHSO_4$. Ortho-phosphoric acid, class III., will furnish three sodium phosphates: Tri-sodium phosphate —Na_3PO_4, di-sodium phosphate—Na_2HPO_4, and mono-sodium phosphate—NaH_2PO_4.

Valency.—To avoid misunderstanding it is necessary to explain why, for example, sodium chloride is represented by NaCl, and zinc chloride by $ZnCl_2$. The reason is that the formulæ chosen alone harmonise with the facts as found by chemical

analysis. Thus experiment shows that 23 parts by weight of sodium unite with 35·5 (approx.) parts of chlorine; as Na represents 23 pts. by weight of sodium and Cl 35·5 parts of chlorine, the formula NaCl is the only possible formula; and it should be noted that, in terms of the Atomic Theory, one atom of sodium takes the place of one atom of hydrogen in hydrogen chloride.

Similarly, analysis reveals that 32·5 parts of zinc are combined with 35·5 parts of chlorine in zinc chloride. Now Zn=65 parts of zinc, therefore to make a formula in accordance with the analytical results, and at the same time to preserve the integrity of the atoms, we must represent one atom of zinc as uniting with two atoms of chlorine—$ZnCl_2$. In this compound the atom of zinc takes the place of two atoms of hydrogen.

In a similar way the formulæ $NaNO_3$ and $Pb(NO_3)_2$ for the nitrates of sodium and of lead can be justified. Atoms like those of sodium, potassium and silver which take the place of—or have the same combining power as—one atom of hydrogen are called *monovalent* (i.e. worth one atom of hydrogen); atoms of zinc, lead, barium, calcium take the place of two atoms of hydrogen, and are termed *divalent*: for a similar reason aluminium is called *trivalent*.

Non-metals like oxygen and sulphur and nitrogen do not displace hydrogen, but combine with it to form the compounds water, H_2O and hydrogen sulphide, H_2S, and ammonia NH_3, and it will be obvious that oxygen and sulphur are divalent, and nitrogen is trivalent. *The valency of an element therefore states the number of atoms of hydrogen which the atom combines with or displaces.* It may always be found by dividing the atomic weight by the equivalent.

Valency of the more common elements.

Monovalent	Divalent	Trivalent
Ag	Ba	Al
Cl	Ca	Fe(ferric)
H	Cu	N
Hg(mercurous)	Fe(ferrous)	P(in PCl_3)
K	Hg(mercuric)	
Na	Mg	
Cu (in Cu_2O)	O	
	Pb	
	S(in H_2S)	
	Sn(in $SnCl_2$)	
	Zn	
	Mn(in $MnCl_2$)	

Tetravalent	Pentavalent	Hexavalent
C	N(in N_2O_5)	S(in SO_3)
Si	P(in PCl_5)	
Sn(in $SnCl_4$)		
S(in SO_2)		

It will be noted that in some cases an element has more than one valency; but the number of valencies is never large. The Theory of Valency is grounded on the assumption that the elementary atoms have only a *limited* combining power. It has proved of the greatest service in the study of the compounds of carbon-organic chemistry—the whole theoretical structure of which is founded on the assumption that the carbon atom is tetravalent. E. H. T.

LIGHT.—VII

20. Defects in the Eye.—The commonest defects of the eye are due to the lens, or at least can be partially corrected by modifications in the lens. Other defects, such as colour-blindness, imperfect transparency of the lens or humours, cannot be in any way overcome by optical devices.

Myopia, or "short sight," is due to the eyeball being too long, so that when the lens is at rest the

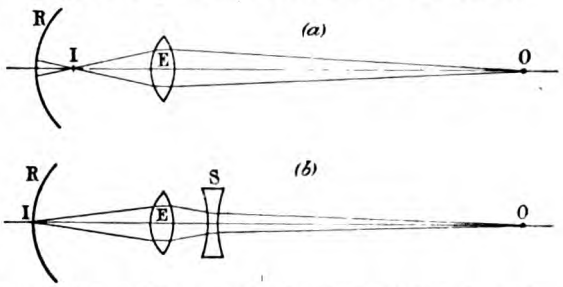


Fig. 63.—Myopia, or short sight, is due to the eyeball being too long, so that the image, I, of a distant object, O (*see* diagram (*a*)), is formed in front of the retina, R. This can be corrected by a concave spectacle, S (*see* diagram (*b*)).

image of a distant object is formed in front of the retina, instead of on it. In other words, the lens is too powerful, and needs to be corrected by a concave spectacle (Fig. 63).

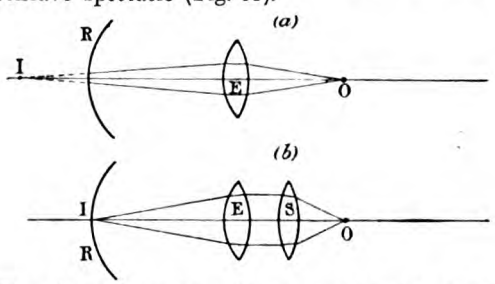


Fig. 64.—Hypermetropia, or long sight, results from the eyeball being too short and the image being formed behind the retina (diagram (*a*)). This can be corrected by a convex spectacle (diagram (*b*)).

Hypermetropia, or "long sight," results from the opposite condition; the eyeball is too short; and even when the limit of accommodation is reached, the image of a near object is formed too far away. A more powerful converging lens is necessary: hence the use of a convex spectacle (Fig. 64).

Astigmatism is due to a defect in the structure of the lens. If a lens has not the same curvature in

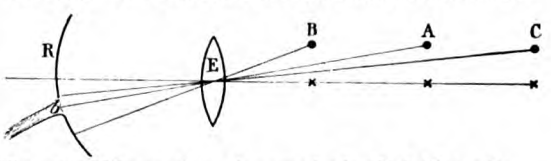


Fig. 65.—Illustrating the method of finding the blind spot.

the horizontal direction as it has in the vertical, it is clear that all parts of an object cannot be brought to the same focus. An eye which does not suffer from this defect can look at a series of parallel lines in any direction without confusion. If the eye is astigmatic in the vertical plane, a series of parallel lines in a vertical direction will run into one another in a confused manner, instead of standing out separate and distinct.

The existence of the blind spot can be shown in the following simple way. Make a small black cross on paper and a black dot about three inches to the left of it. Close the right eye, and hold the paper so as to look straight at the black cross with the left eye. If the page is about six or seven inches from the eye, the black dot will be invisible. Move the paper nearer, or farther away, and the dot becomes visible, because its image is no longer on the blind spot.

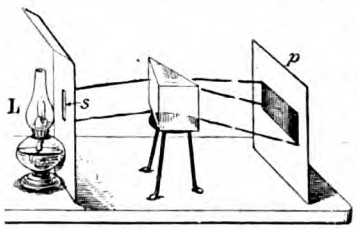


Fig. 66.—A simple experiment with the prism.

21. Colour—the Spectrum.—When experimenting with the prism the fringe of colour surrounding all objects seen through it could not fail to have been noticed. It is now necessary to study a little more in detail the nature of these colours, and of colour in general.

Cover the light of a good lamp with cardboard in such a way that the only light which falls on the prism is that which passes through a narrow rectangular slit cut in the cardboard. Place the prism on a stand as nearly as possible in the position of minimum deviation, and allow the light which passes through the slit to fall on a screen, Sl. Then, instead of a slit of white light, we obtain on the screen a broadened band of colours. In a dark room it will be perfectly easy to make out the colours and their order (Fig. 67).

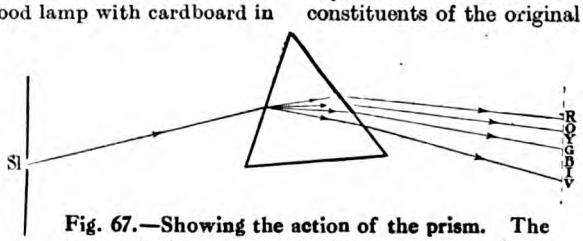


Fig. 67.—Showing the action of the prism. The letters indicate the initial letters of the colours (*vide below*).

The band of colour thus obtained is called a *spectrum*, and in this case the spectrum is *continuous*, the colours gradually shading off into one another without a break. The order of the colours is the same, whether we use the light of a lamp or a candle, the electric light or the limelight, or sunlight, to illuminate the slit; beginning nearest the apex of the prism, they appear in the following order—*red, orange, yellow, green, blue, indigo blue, violet*, and lastly *ultra violet*.

It thus appears that the prism is able to decompose the original *white* light of the source into these and a great number of intermediate colours. And thus we learn the lesson first taught by Newton, that white is really a compound of all the colours of the rainbow. All the colours of nature are involved in white light, and the colours of common objects result from the action of different materials on white light.

Thus, why is blue glass blue? Hold the glass in front of the eye, and observe the resulting effect on the spectrum. All the colours have vanished except the blue and a very little of the red. Obviously the blue glass has dissected the white light—absorbing most of the constituents, but allowing the blue to pass. Similarly, red glass allows only the red to pass. So if you look through red and blue glass together, it ought to be opaque, because the light transmitted by the one is absorbed by the other. And so it would be if the blue really cut off *all* the red light, and the red cut off the blue quite absolutely. Thus the colours of transparent objects result from a selective absorption from the constituents of the original light.

The colours of opaque objects in a similar way result from selective absorption and reflection: a red paint absorbs all but the red constituents of the original light; the red is reflected back and gives its colour to the object. The light must penetrate the surface of the body slightly, or its peculiar construction could not have its effect; when it does not penetrate there is no selective absorption. It is probably well known that the froth on a glass of ale is white, and not yellow, because the reflection is entirely superficial.

Many colours seen in nature, such as purple, mauve, peacock, etc., are mixtures of the spectrum colours in various proportions. Even those which appear pure are very rarely so: the matter can

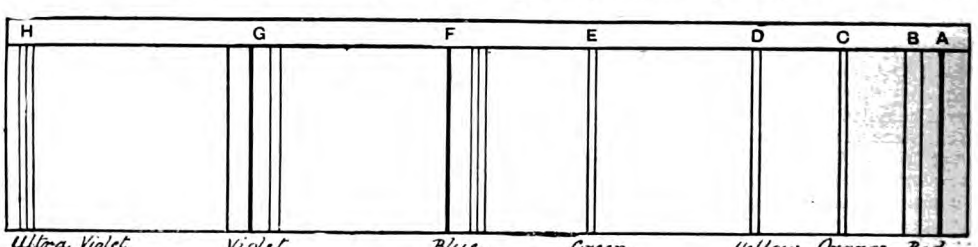
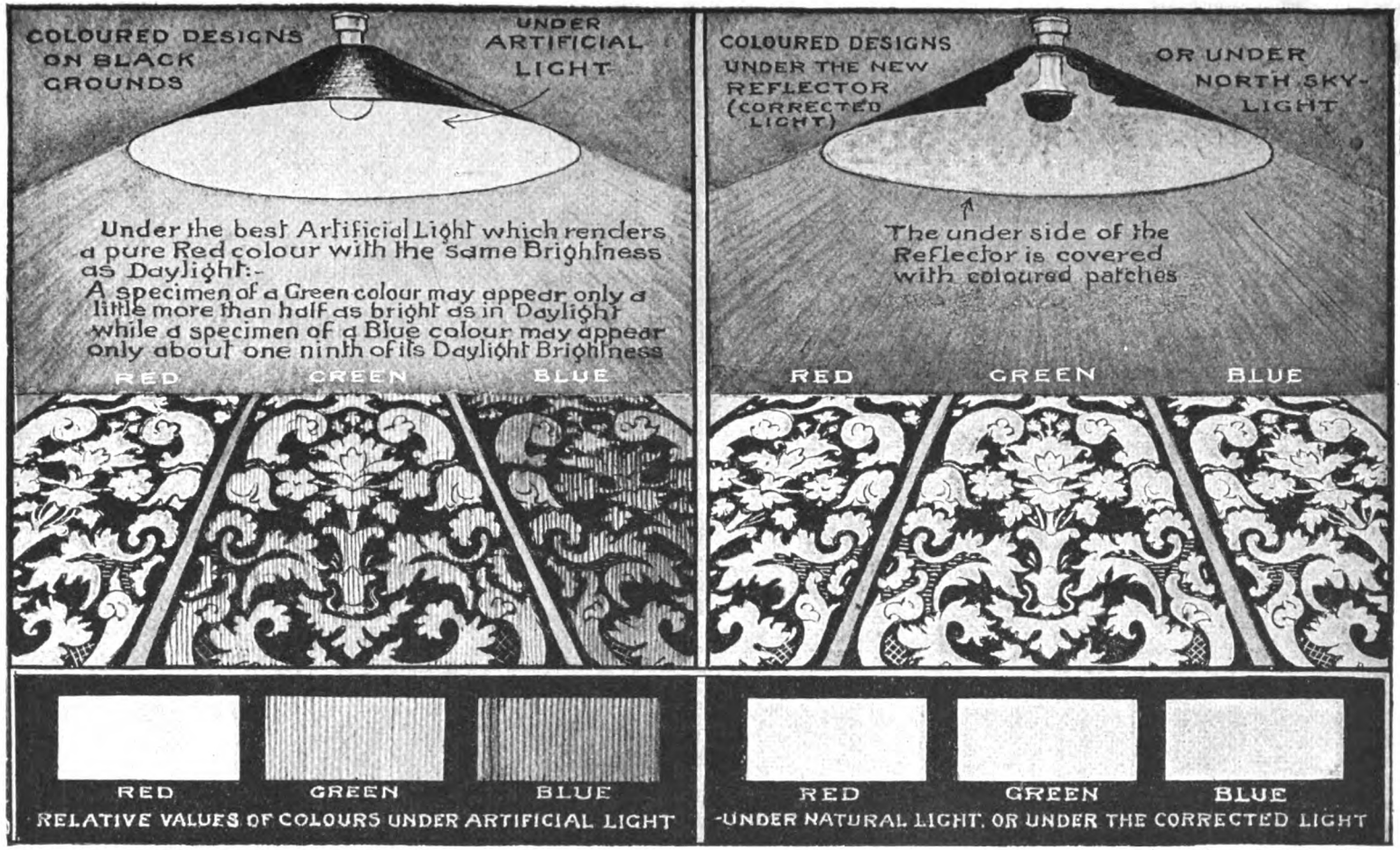


Fig. 68.—White light broken up into its constituent rays.



Drawn by W. B. Robinson.

DAYLIGHT AND ARTIFICIAL LIGHT.

Daylight and artificial light contain rays of light of the same colours, but in artificial light (*see* above : left) red and yellow rays predominate to such an extent as to give an entirely wrong value to most dyes and pigments. The Sheringham Reflector (*see* above : right) is a device, recently exhibited before the Society of Illuminating Engineers, for correcting artificial light, and is likely to prove of great value to all colour industries and to surgery.

easily be settled with a prism. But colour must not be regarded as an inherent property of bodies. It depends upon their molecular construction in the way we have seen, but it depends upon the incident light also. In a photographer's dark-room, for example—into which red light alone is allowed to enter—a blue tie looks black, and a

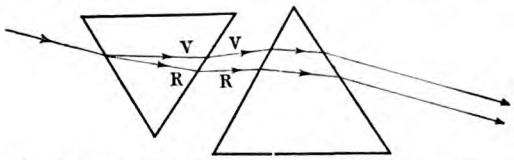


Fig. 69.—A recombination of the spectrum colours so as to form white can be effected by a second prism so placed as to be antagonistic to the first.

piece of blue glass looks opaque, because both absorb the red light which alone falls on them; a white object would look red, because it reflects all the light that falls on it.

When the colour of a transparent substance is a mixed one, it is very rare to find all the constituents

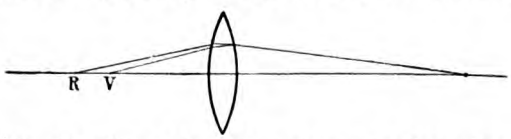


Fig. 70.—Illustrating the chromatic aberrations of a lens. Images seen through a single lens are always coloured.

absorbed or transmitted in equal proportion. Thus blue cobalt glass is distinctly redder in thick masses than it is in thin layers. Two or three suppositious figures will explain the reason for this.

Suppose the blue rays to be absorbed at the rate of 20 per cent. per inch, and the red rays in the mixture at the rate of 5 per cent.; and suppose, after passing through one inch, the proportion of blue to red is 100 : 10; which would make the blue dominant. After another inch, the proportion will be 80 : 9·5, i.e., 100 : 11·625, which shows that, while the blue still prevails, the red plays a greater part in the mixture.

If a blue pencil mark crosses a red one on a white sheet of paper, the place of intersection will be green. It would be black if the two pencil colours were pure; and there must have been a certain amount of green common

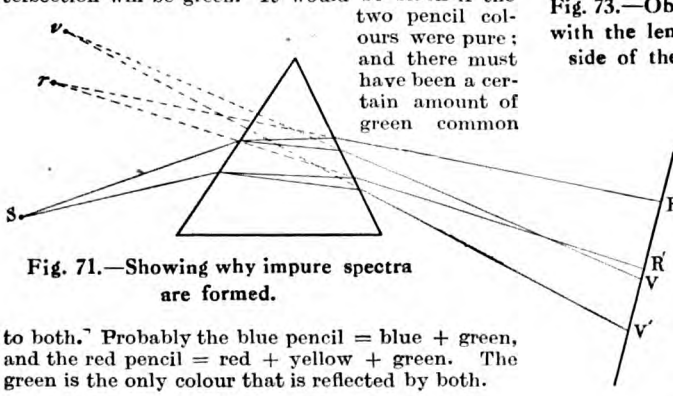


Fig. 71.—Showing why impure spectra are formed.

to both. Probably the blue pencil = blue + green, and the red pencil = red + yellow + green. The green is the only colour that is reflected by both.

The cause of colour in the purely physical sense is found to lie in the differences of wave-length of light. Those ether-waves which arouse the sensation of red are found to be longer than those which induce violet, with the other spectrum colours intermediate to them. Why the eye makes this distinction, and how, is a difficult problem of physiology and psychology. It is found, however, that all the colour sensations can be induced by means of three alone.

These three *primary colours* (*see* Plate, facing p. 321, Vol. I.) are to be found in the red, green and bluish-violet parts of the spectrum. The sensation of yellow can be induced by a mixture of the red and green primary colours—spectrum colours, that is, and not coloured paints, be it remembered. If the red is more intense than the yellow, orange is perceived. Most of our colour sensations can be described in terms of these three primary colours.

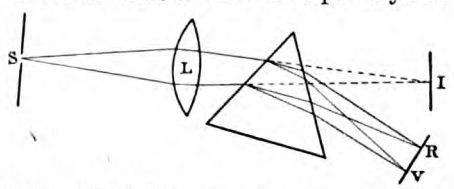


Fig. 72.—Obtaining a pure spectrum by focusing an image of the slit on the screen by means of a convex lens.

Take the interesting phenomenon of *complementary colours*. If a circular card be painted deep blue and placed on a sheet of white paper and looked at intensely for a minute or so, it will be soon seen to be edged with yellow; and if the card be removed before the eyes are rested, a yellow circle will appear in the place of the blue. This yellow is the colour which, along with the blue, would make up white: the two colours are then

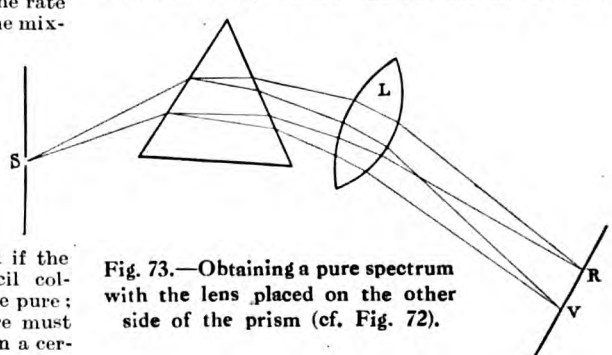


Fig. 73.—Obtaining a pure spectrum with the lens placed on the other side of the prism (cf. Fig. 72).

said to be complementary. Now let us suppose, for simplicity, that the blue used was the primary blue-violet. Then, white = R + G + B, where the letters R, G, B, stand for the three primary colours.

In order to have the sensation of white, the eye must receive R, G, and B together in suitable intensity. But the eye has been receiving B for some time, and has become fatigued

to that sensation; hence it cannot respond to it with sufficient energy to produce white. What the eye receives is R + G + B, or white; what the eye responds to is white – B, i.e. R + G, which = yellow. Consequently the white patch looks yellow, after the eye has become fatigued with the blue.

The recombination of the spectrum colours so as to form white can be effected by means of a second prism so placed that its action is antagonistic to the first (Fig. 69). If the prisms are of the same material they must be equal in size, and together they act as a parallel plate which produces no colours. When there is no refraction there is no *dispersion*.

When a circular piece of cardboard is painted in sectors with the various colours of the spectrum in suitable proportion, and then spun rapidly round on an axis through its centre, the card looks a dull grey, which is merely a mixture of white and black.

It must be remembered that a lens behaves towards light as if it were a double prism. Hence images seen through a single thick lens are always coloured. This is known as the *chromatic aberration* of the lens. The violet rays being more refracted than the red are brought to a focus nearer to the lens (Fig. 70). In the case of a concave lens, however, the violet is refracted farther away from the axis than the red; consequently a concave lens will correct the chromatic aberration of a convex lens. It should, however, not be of the same kind of glass.

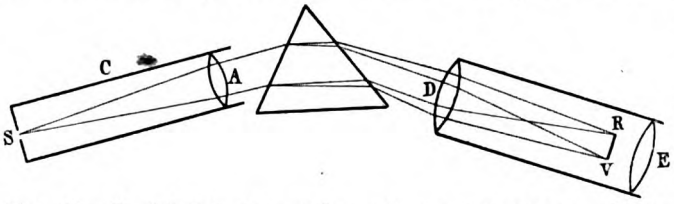
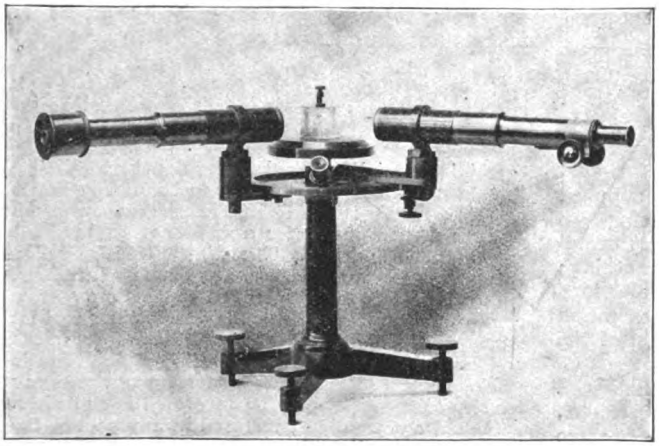
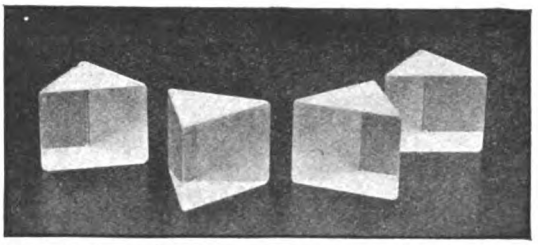


Fig. 74.—Explaining the action of a spectroscope. Light enters collimator, C, by the adjustable slit, S, placed at the principal focus of the convex lens, A. Thus a small parallel pencil of rays falls on the prism. The second tube is practically a telescope. It contains two convex lenses, D and E. The first produces in the tube a real spectrum which, falling at the principal focus of the lens, E, is viewed as a virtual image by the eye.



THE SPECTROSCOPE.

22. Pure and Impure Spectra. — In Fig. 67 we have shown the course of one ray



To obtain a broader spectrum a train of prisms is often used.

only, from the slit to the prism; but of course there will really be a small pencil of rays, and each one striking the prism at a different angle will form its spectrum R V; and these spectra will not all coincide exactly (Fig. 71). There will be a certain amount of overlapping, and the spectrum obtained will be *impure*, because at many points the colours will be mixed. When the spectrum is such that the colours do not overlap, and one colour only is found at any point in it, the spectrum is said to be *pure*.

In order to obtain a pure spectrum we first focus an image of the slit on to the screen by means of a convex lens, L (Fig. 72). Then insert the prism in the path of the light from the lens, and move the screen to catch the spectrum formed, but taking care that the screen is kept at the same distance from the lens as before. The lens now brings all the rays of any particular wavelength or colour, to one focus on the screen, and there is no overlapping. The same result is obtained when the lens is placed on the other side of the prism (Fig. 73).

The *spectroscope* is an instrument for obtaining a pure spectrum and viewing it with the eye. It consists of two brass tubes mounted on a circular stand, each tube being movable around the circumference of the stand (Fig. 74). Between the two tubes is the prism. The light enters the first tube, C, known as the *collimator*, by the adjustable slit, S, which is placed at the principal focus of the convex lens, A, at the other end of the tube. Thus a parallel pencil of rays falls on the prism. The second tube is a telescope. E. W. E.

ELECTRICITY AND MAGNETISM.—VII

Electric Currents. — SINCE the ultimate nature of electricity is unknown, it is impossible to define an electric current. It may be stated, however, that under certain conditions electricity exists in a form that appears to flow at an enormous rate along suitable conducting materials from one place to another.

What are these conditions under which a current of electricity may exist ?

Let us again consider the analogy between current electricity and flowing water.

If there is to be a definite stream of water there must be a source that supplies water as quickly as it is removed, and a channel must exist for the passage of the flowing water. A "flow" of electricity exists under conditions that are analogous.

There must be a source that supplies electricity as quickly as it flows, and a definite pathway having no breaks must enable the current to complete its journey from, and back to, the apparatus producing it. The conducting pathway along which the current is said to "flow," is called the *circuit*, but before considering this in any detail we will consider the chief sources of a continuous flow of electricity.

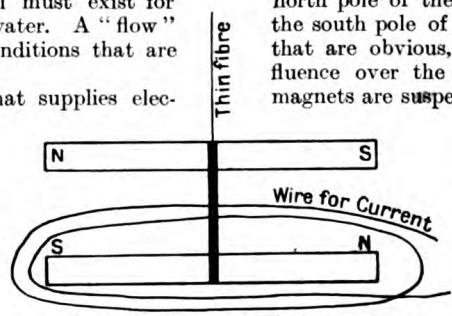


Fig. 24.—An Astatic Galvanometer.

The most casual observer is aware that current electricity is capable of doing great varieties of work. In the propulsion of electric railways and cars the current does work of a mechanical nature, in the process of silver-plating chemical work is performed, in electric lamps the passage of the current produces light, one's dinner may be cooked in an apparatus that transforms the energy of electricity into heat, and a listener may recognise the voice of a friend speaking through the telephone as a direct result of variations in the strength of an electric current.

It was noticed in Vol. II., p. 269, that we cannot regard electricity itself as being a form of energy, hence a current of electricity must be supplied with the necessary energy for performing the various forms of work that we have just exemplified. Energy cannot be created out of nothing; it must come from pre-existing energy, and in a brief general survey of the chief ways of generating current electricity we shall note the origin of the current's energy.

If the energy of electricity can be transformed into that of motion, chemical work, heat, etc., is not the converse true, that the energy of these can be used for the production of an electric current ? Our observations will answer this question.

Current Detectors.—We must have some visible proof that a current is being produced when we are performing various experiments. The influence of a wire carrying a current over a compass needle has been already noticed, and for some of the experiments we can use this to show that a current is present.

Should a very feeble current be produced the earth's directive power would be too great compared with that of the current, consequently the compass would not move at all. Something much more sensitive than an ordinary compass must be used in such cases. It is possible to arrange magnetic needles in such a way that they would be influenced by a feeble current of electricity but not by the earth's directive force.

Two small magnets of exactly equal length and magnetic strength can be fixed rigidly together in such a way that one is about three quarters of an inch above the other, and parallel with it. The north pole of the upper magnet must be over the south pole of the lower one. For reasons that are obvious, the earth has no direct influence over the arrangement, and when the magnets are suspended by means of a silk fibre they will not set themselves in any special direction. They do not necessarily stand in the magnetic meridian, hence the name *Astatic pair* is given to such an arrangement. (Greek = not standing.)

If a coil of insulated wire is wound around the lower magnet, the pair will be deflected even when a feeble current of electricity is flowing along the wire. Such an apparatus is called an Astatic Galvanometer (Fig. 24). Since the magnets must be of exactly equal strength and mounted rigidly one exactly parallel with the other, the student may find it a matter of considerable difficulty to make one.

Production of a Current.—We will next see how to produce a current by means of magnetism and motion.

Experiment 22.—*To generate an electric current by means of magnetic influence and mechanical work.*

Obtain about three yards of insulated wire similar to that used in Experiment 21, and wind most of it around a hollow cylindrical piece of cardboard, such as that used as a box for a mantle of an inverted gas burner (Fig. 25.). The wire should be coiled in layers one over another, until a few inches at the end are left for purposes of connection. After removing the cotton or other insulating material from the ends of the wire, attach them to those of the coil of wire around the lower needle of the Astatic galvanometer. There is now a complete pathway for any current that may be generated in the wires.

Should a current be generated in any part of the linked-up coils, it will cause the Astatic pair to be deflected, or even violently agitated according to the strength of the current. *Suddenly* plunge either pole of a strong bar magnet into the coil C, and notice that the Astatic galvanometer moves, indicating the presence of an electric current. Retain the magnet within the coil for a minute, then quickly pull it out. The galvanometer again indicates the presence of a current.

What produced the current in the coil of wire? If a non-magnetic substance such as wood, or unmagnetised steel were plunged into the coil C we should find that no current would be produced. Obviously magnetism has some influence in the case.

Yet it is not correct to say that magnetism *alone* produced the current, for while the magnet remained motionless in the coil no current was flowing along the wires. Evidently the movement in and out of the coil is an essential condition for the production of the current. It is quite clear that magnetic influence and motion are both necessary, the reason being that the *magnetic influence extending through the coils of wire must vary in intensity if a current is to be produced,* and mechanical motion is necessary to produce this magnetic variation. Any power the current may have for doing work is due to the mechanical work done in causing the variation of magnetic influence.

The electricity used in the working of electric traction and in lighting is produced by complicated machinery in which magnetic influence extending through coils of wire is being rapidly varied in intensity by means of mechanical work.

An electric current can also be produced by chemical means.

A few inexpensive materials will be required. Ask any chemist to prepare a solution of dilute sulphuric acid in the proportion ten parts of water to one part of acid.

Half a pint of such a solution, which should be kept in a stoppered bottle, will be sufficient, and can be obtained for a few pence.

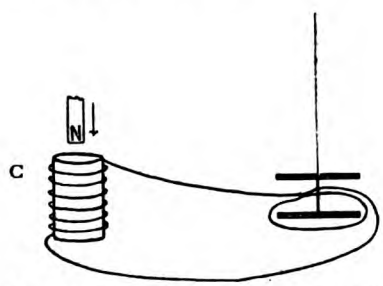


Fig. 25.—Producing an electric current by means of magnetism and motion.

Other materials required include a piece of ordinary commercial (i.e. impure) zinc about two inches square and having a thickness of any dimension up to a quarter of an inch; a piece of sheet copper about the same size though much thinner; and either a glass or earthenware jar, such as a small jam pot. The zinc and copper can be obtained at any ironmonger's, or perhaps more economically from a plumber.

Experiment 23.—*To produce an electric current by chemical means.*

Into the small jam pot pour sufficient acid solution to occupy about two thirds of the pot. Exercise care in using the acid, otherwise it may corrode your fingers or clothing. Punch a hole in the zinc and copper plates so that pieces of wire may be attached to them. Should the zinc be too thick, wind some bare wire tightly around one end. In any case the cotton must be removed from the insulated wire where it is connected to the zinc and copper. Attach the other ends of the wires to the galvanometer as shown in the diagram. Now place the zinc in the acid solution and notice that a brisk effervescence takes place, due to the liberation of a gas that should not be inhaled. Next place the copper in the solution opposite the zinc *but not touching it.* Directly the copper is immersed the galvanometer indicates the existence of a current flowing along the wires (Fig. 26).

Take out the zinc or copper and the current ceases. Keep the metals in the solution, but cut one of the wires. The current ceases directly the wire is cut.

The agitation of the galvanometer needle indicates the presence or absence of a current, and it may be noted that in the performance of this experiment a stronger current is obtained than in the case of the previous experiment, hence a piece of wire coiled above and below an ordinary compass will serve as a galvanometer in this case.

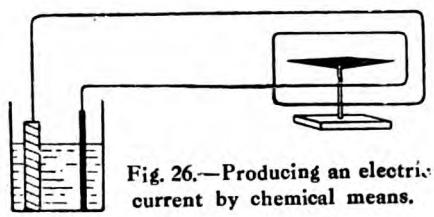


Fig. 26.—Producing an electric current by chemical means.

The glass jar, solution, and metallic plates collectively form a piece of apparatus known as a *simple cell.* The exact mode of working in such a cell will come under consideration in the next lesson, but we must understand that the current produced in the experiment is due to the chemical work taking place in the cell. The energy of the current in this case is the result of chemical attraction between zinc and a certain constituent of sulphuric acid, the effervescence in the solution being caused by the escape of hydrogen gas, for which the zinc has no attraction.

The student should notice *where* the hydrogen bubbles escape when both zinc and copper are in the solution, as we shall have occasion to refer to the matter later on.

Electric currents obtained by chemical means are very useful since they are strong enough to work bells, the telegraph, and other appliances which do not require such powerful currents as are necessary for lighting and traction.

Heat, light, and sound also may be utilised for the generation of current electricity, but the currents obtained by such means are so feeble that they are of little importance compared with those derived from sources that we have examined. The telephone, however, is an extremely useful instrument in which variations in sound (i.e. in a speaker's voice), cause variation in magnetic influence extending through coils of wire, and thus produce a current that may be changed back into variations in sound at the other end of the line. A more detailed study of this appliance must be reserved for a future lesson.

The Circuit.—In performing Experiment 23 the wire was cut and the current ceased to flow. The pathway for the current must be absolutely complete, the slightest gap being sufficient to destroy it.

We speak of the complete pathway traversed by a current as the circuit, but there are two parts to a circuit—an *external* circuit comprising all those conducting materials outside of the apparatus generating the current, and an *internal* circuit within the generating apparatus itself. Thus the acid solution between the zinc and the copper was the internal circuit in Experiment 23, while the wires and the galvanometer formed the external circuit. Of course a circuit must consist of materials that conduct current electricity, and these are metals, of which silver and copper are the best; some liquids, such as acid or salt solutions; and some forms of carbon, especially the kind called graphite. Those materials which do not conduct electricity are called *insulators*, the most useful of these being india-rubber, porcelain, and silk. Wires are usually covered with india-rubber and perhaps cotton in addition, but in some pieces of apparatus green silk is used to prevent the escape of electricity from the wire. In the case of the telegraph, porcelain knobs serve to separate the bare wire from the posts.

Insulators.—It must be clearly understood that as far as practical results are concerned, the terms insulator and conductor are more or less relative. Whether a substance conducts a current of electricity or not is largely a matter of electric pressure or voltages.

Thus, the human body is a non-conductor or insulator as far as a low voltage current such as that from two or three cells is concerned, but is a conductor when the electricity is at a higher voltage. A person can handle the bare terminals of small cells with impunity, but receives a nasty shock if he forms part of a circuit of a powerful current such as that of lighting mains, etc.

Again, ordinary water, i.e. water without acid or salts in solution, is a non-conductor for weak currents and a conductor for electricity at a higher voltage.

On the other hand, some substances such as dry glass and dry air are insulators with electricity of very high voltage.

Good insulators, other than those mentioned above, are the mineral mica, used in certain parts of dynamos, etc.; paraffin-wax, employed in the construction of induction coils, etc.; vulcanite and celluloid, which are used to form certain parts of accumulators.

Mica is of course the name given to a group of rock-forming minerals. Their characteristics are their shiny appearance, their toughness and flexibility. Crystals have as a rule the form of hexagonal scales. Forms of mica vary from transparent or colourless through tints of yellow, green, red and brown to black.

They are bad conductors not only of electricity but also of heat. They have in consequence important commercial applications, the most extensive being for electrical purposes. Smooth flexible sheets of mica are made for use as insulators in electrical machinery. L. M. P.

ZOOLOGY.—XVI

UNDER the title of *Picariæ* are grouped a number of families which collectively are described as Woodpeckers from the fact that they use their long and sharp bills to dig holes in trees in which to deposit their eggs and to find food. The search for food is conducted generally upon a dead or decaying branch from which the Woodpecker levers the bark; the nest hole, however, may be discovered with equal frequency in sound wood. In his food-hunting expeditions an important part is played by the Woodpecker's tongue, which he thrusts into the hole. The tip of the tongue being covered with a sticky substance, any insects which the hole may contain are soon safely secured.

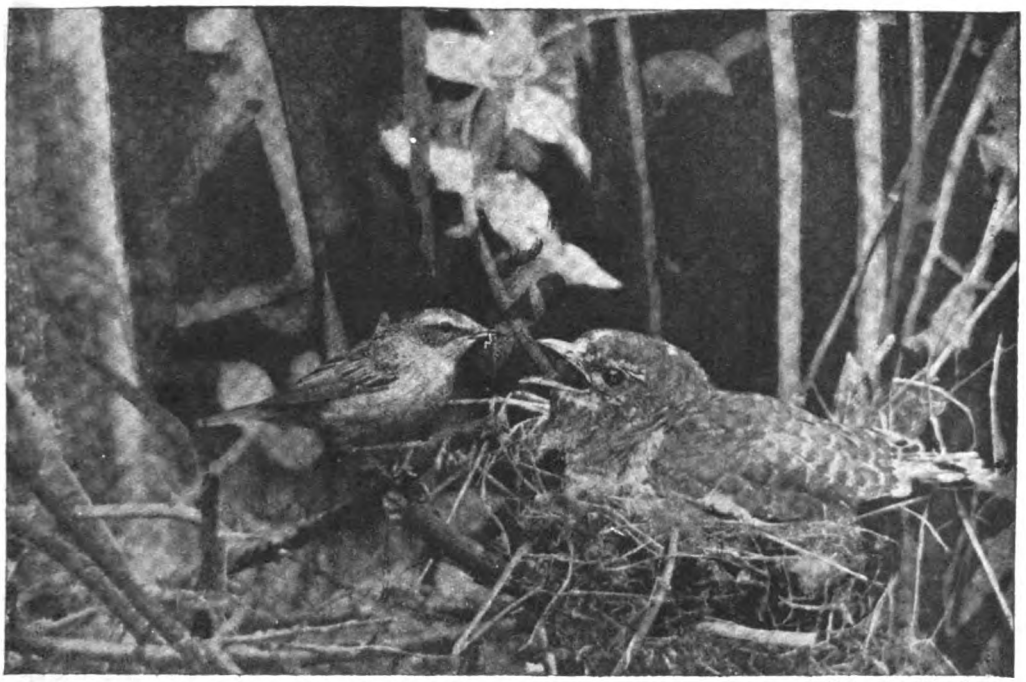
Picarian Birds

The Great Spotted Woodpecker, black and white with a dash of red under the tail, is fairly numerous in England. The Green Woodpecker, which is the largest of the resident species, is about twelve inches in length. The Lesser Spotted Woodpecker, the smallest of the three British representatives of this family, is somewhat similar in colour to the Great Spotted Woodpecker, and may be seen with most frequency south of the Thames.

The Kingfishers are a family distributed more or less throughout the world. The British representative is exceedingly handsome, and may frequently be seen south of the Tweed. He feeds principally upon such fish as minnows and small trout, but does not despise a snail or a water-beetle should one come his way.

The Wryneck is sometimes known as the Cuckoo's Messenger, from the fact that he generally reaches this country from Africa a few days in advance of that bird. He is about the size of the lark, and nests in any convenient hole which he can find ready made.

The Cuckoo, which reaches England about the middle of April, always attracts to himself a considerable amount of popular attention, many people, otherwise entirely reliable, making it a point of honour to be the first to hear his peculiar note. The somewhat unprincipled habit adopted by the female of depositing her eggs in the nests of other species is known everywhere. In Britain the nests of pipits, wagtails, sparrows and similar birds are chosen apparently indiscriminately, while the variety of nests made use of in this fashion in other lands



PARENT OF A USURPING CUCKOO. *Photo: O. Pike, Tring.*

A Sedge Warbler feeding its voracious foster-child. The Cuckoo's unprincipled habit of depositing eggs in the nests of other birds is known everywhere.

A KINGFISHER AND ITS PREY. *Photo: Jacques Boyer, Paris.*

The Kingfisher feeds chiefly on minnows and small trout, but does not despise snails and water beetles.

produces a total that has been estimated to reach one hundred and forty odd.

The interesting suggestion has been made that the individual Cuckoo chooses the type of nest in which it was reared itself. Once the eggs have been laid the parent birds concern themselves no more about their offspring, not even lingering in the neighbourhood until the fledglings are sufficiently old to undertake their migrating flight. However, no harm appears to come of this neglect, for the young Cuckoo sooner or later starts off alone upon his long flight to Africa, with an assurance that the event seldom fails to justify, so sure is its directing instinct.

The Nightjar, sometimes called the Goatsucker, is an insect-eating bird whose silent flight is a feature of the twilight. The name Goatsucker is a relic of the ancient myth that this bird took the milk of goats. There is, of course, no truth in the suggestion. The Nightjar does not build a nest, but deposits its eggs in some convenient hole in the ground.

The Swift differs from the Swallow in that its four toes point forwards. This fact while assisting the bird when it is climbing, forbids it perching. The Common Swift is black-brown in colour with a grey patch under the chin. It reaches England about the close of April and leaves again early in September.

The Humming Birds of Central and South America comprise some four hundred species, the largest of which, the Giant Humming Bird, is about nine inches in length, while the smallest is smaller than a stag beetle. The plumage of these birds is brilliant.

Photo : Martin Duncan.

THE GREAT HORNBILL

possesses a beak phenomenally developed, but not really very heavy, the outer surface being of the thinnest horn.

Parrots

The Bee-eater, a native of the South of Europe and Africa, is very rarely seen in the British Isles. It is an insect eater, with a chestnut yellow and green plumage. Though, as the name denotes, the Bee-eater is an enemy to the hive, he is equally partial to wasps, butterflies and kindred insects.

Other Picarian birds include the Puff Birds, a family of sombre-clad insect eaters of Central and South America; the Jacamars, the lazy, long-beaked insect catchers of the same region; the Rollers, whose bright plumage is to be seen in Africa and Central Europe and very occasionally in Britain; the Motmots of Central and South American forests, forest-loving birds which feed upon insects and berries; the fruit-eating Trogons of South America, and the Resplendent Trogon of Guatemala, whose tail feathers form valued ornaments.

The Parrot family comprise nearly five hundred different species, and includes the parrots, cockatoos, macaws, parrakeets and brush-tongued parrots. This family is remarkable for the hooded beak, which is largely used by the birds when climbing.

The Toucan, a South American bird, with a beak of astonishing length, and brilliantly coloured feathers, lives chiefly upon fruit, though it sometimes accounts for the eggs or fledglings of other birds. The flesh of the Toucan is frequently eaten, and its feathers are much prized for decorative purposes.

The Hornbill is another bird exhibiting phenomenal development of the beak. It ranges from Africa to New Guinea. As in the case of the Toucan, the bill is not so heavy as its appearance would suggest, the outer surface consisting of the thinnest horn. The Hornbills feed chiefly upon fruit, though many of them also eat small mammals and fish.

The Hoopoes of Asia, Africa, and Southern Europe are insect-eating birds allied to the Hornbills.

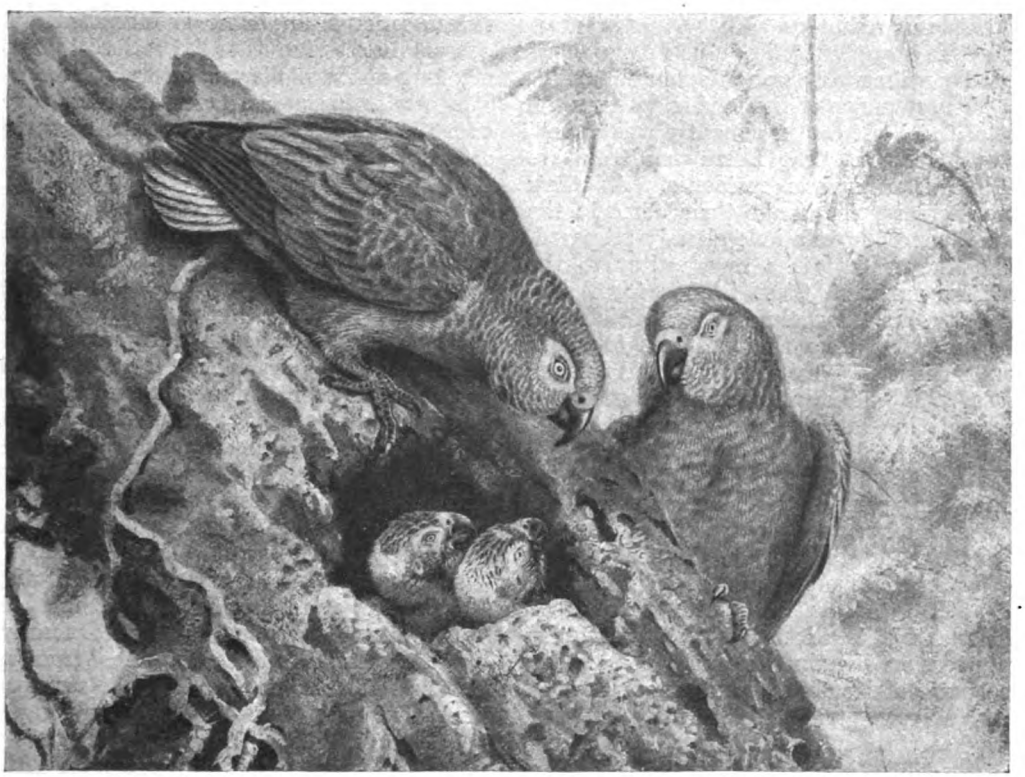
The true Parrot, which has a shorter tail than the Cockatoo and is without the head crest which distinguishes that bird, is found in Asia, Africa and America. The Cockatoos, in some respects the more handsome in figure, are large birds hailing from Australia and the Eastern Archipelago. The Macaws, which are found in America, may be distinguished by their long tails and bare cheeks, while their plumage is brilliant in the extreme. The Parrakeets inhabit India and the Malay Peninsula. The Brush-tongued Parrots, of gay plumage and swift flight, are notable by the brush-like formation of the tip of the tongue.

The Grey Parrot is one of the best known of the True Parrots by reason of its ability to imitate the human voice. Its grey coat and scarlet tail are indeed constantly to be seen behind the bars of a cage and occasionally climbing round the room of its owner. It is found in a wild state in Central Africa. The Yellow-crested Cockatoo is also a popular cage bird. In a wild state it inhabits Australasia. Its plumage is white, and its crest, as its name suggests, is yellow.

The Scarlet Macaw of South America, a good representative of this brilliantly coloured and long-tailed branch of the Parrot family, is sometimes thirty-six inches from the tip of its beak to the end of its tail.

The Owl, the nocturnal bird of prey and the mysterious inmate during the day of some secluded and remote hole or crevice, is a never failing source of interest to the neighbourhood in which it hunts. Everything about this bird combines to make this the case. The fact that it is only seen at dusk, its strange appearance, the eerie silence of its flight, its weird hoot, all these peculiarities tend to-day to make it an object of interest.

From the ornithologist's point of view the Owl is a splendid example of the highly specialised bird. In the manner of its life the owl could not possibly be better fitted to succeed. The food of the Owl, as is generally known, consists of mice, rats, reptiles, bats and insects, and those small field mammals which would rapidly elude it but for the silence of its approach. Its nesting place may be in a hole in a tree, in



GREY PARROTS AND NESTLINGS.

The Grey Parrot is probably the best known member of its family by reason of its ability to imitate the human voice.

an old or ruined building, or in the deserted burrow of a rabbit. Its vision is so powerful by night as utterly to unfit it to stir abroad during bright daylight. The eyes are very forward and entirely unobstructed. The talons are long and sharp, and the fourth toe can be directed forwards or backwards at will. The bird's hearing is exceedingly acute.

The Barn Owl, sometimes called the Screech Owl, is common in Britain and is to be found elsewhere in Europe, as well as in America and Asia.

The Tawny Owl, like the Barn Owl, generally makes its home in some old building. The plumage of the bird is darker than that of the Barn Owl, frequently it is almost brown in colour. The Burrowing Owls are well-known American residents. As their name suggests, they make their home in the ground, generally in a hole already prepared.

The Snowy Owl is a rare visitor to the northern parts of these islands from sub-Arctic regions. Its plumage is thicker and more extensive than that of Owls found in warmer climates. Even the legs and feet are covered. It differs also from the others of the family in that it hunts by daylight.

Long-eared Owls

The Long-eared Owl, which has gained its name from its erect ears, may frequently be seen in Britain. The Short-eared Owl also, but more rarely, visits these shores.

The Great Eagle Owl, with russet and black plumage, is a formidable bird now very rarely seen in Britain, but fairly common in some parts of Northern and Central Europe.

The Pigeon tribe is widely scattered throughout the world. Domestic Pigeons, though very varied, are said to be descended from the Blue Rock Dove, which is still common in many parts of Europe. In its domestic affairs the Pigeon is considerably in advance of many bird species, since it pairs for life and bestows considerable attention upon its offspring.

Though most Pigeons are powerful fliers, prolonged flight, such as is undertaken during Pigeon racing, is not instinctive, the bird gaining its ability to find its way home by means of a series of flights in each of which the distance from home is increased. The general impression that "Carrier" Pigeons are long-distance fliers is entirely erroneous. The carrier is, in fact, comparatively a very poor flier. Great success, however, frequently attends the use of the Homing Pigeon.

Homing Pigeons

Of the many theories that have been advanced to account for the ability of the Pigeon to find its way home from great distances something may be said for the theory that attaches importance to the position of the sun. At any rate, it has been found that birds liberated when the sun is obscured appear to experience greater difficulty upon the homeward flight.

The Ring Dove or Wood Pigeon, a timid bird with a pleasant note, is becoming increasingly numerous in Britain. It feeds principally upon grain and seeds. The Turtle Dove, a summer visitor to Britain, is about a foot or slightly less in length.

The Stock Dove, a smaller bird than the Wood Pigeon, derives its name from the fact that it nests in the stocks or stumps of trees, though it is also to be found nesting upon certain cliffs. The American Passenger Pigeon is famous for its long journeys. A. B.

Photo: B. Hanley.

LONG-EARED OWLS,

so called on account of their erect ears, may frequently be seen in Britain.

BOTANY.—I

1. General Observations. — THE study of plants, which is the province of the science of Botany, is one of unfailing and unceasing interest to any lover of Nature; and it is the object of the present series of lessons to enhance that interest by an elementary presentment of the scientific principles which are necessary to make the study profitable and illuminating.

With these principles in the mind, Nature becomes an infinite source of the simplest, yet most intelligent, delight: mysterious and beautiful as before; but enriched with a wider significance and infused with the golden threads of laws otherwise unknown and unperceived. Without losing the artist's pleasure in the beauty of Nature, we obtain a deeper glimpse into her harmony and her ordered development.

The fundamental thing in botanical science is *observation*, which must be carried on at all times, in the field and the garden, in the woods and by the sea. Accurate observation is our vital air: without it, all lessons in botany are mere empty verbiage. We insist on this from the outset—that the student must learn to look at the plant-world with open eyes and critical mind, seeing the facts and questioning them for himself.

He should get into the habit of making clear diagrammatic sketches from Nature—bold sketches which show up clearly the important features of interest to him. The drawing should be accurate, but not meticulously so: showing the right relationship and proportion of the parts, but not elaborating details for the sake of effect. No great artistic skill is needed for the sort of sketch required, and very little practice will bring out all that is necessary.

Another valuable habit in Nature-observation is that of keeping a note-book, containing a record of little happenings, and queries suggested by thoughtful observation. As thus :—

> *Nov.* 1.—Catkins noticed on the hazel-bushes. None visible on oak, ash, elm, beech. Do not these trees have catkins? Or, when are they first visible?

Here are accurate observations of fact, and questions to be settled by further observation. Information thus gained has a richer value altogether than if it were merely learned from a book. The text-book and the "Flora" are necessary parts of the machinery of the botanist; but observations are his raw material.

As observations accumulate, however, the need grows of a guide among the labyrinth of disconnected facts—a guide which shall reduce them to order and help to interpret them. This is the function of a scientific book, and the present series of lessons has been drawn up with that end in view—to help, in short, the student of botany to teach himself.

At the beginning he will possibly be repelled by the terminology of the subject; but Latin terms will only be employed here when they are of real service and in the end lighten the student's labour. He is strongly advised to master unfamiliar names from their first introduction, and to apply them to his own observations on every opportunity. If he does not shy at the Chrysanthemums and Auriculas of his garden, why need he be alarmed at the Compositæ and Primulaceæ which are the family names of these plants?

2. Morphology and Physiology.—The study of all living things may be approached from two standpoints, the morphological and the physiological. We may, in examining a plant, for example, pay our attention chiefly to its appearance, its size, shape and consistency, the proportion and arrangement of its various parts—in a word, to its structure or build: this is *morphology*, the science of structure (Gk. *morphe*, shape).

Or, on the other hand, we may devote ourselves to the work of the plant, its mode of action, and the functions of the different parts: this is *physiology*, the science of function.

Of course, these two aspects of our subject cannot be kept wholly distinct; we shall always be seeking to interpret structure in terms of function, to show the use of this or that feature of structure. In general, nevertheless, morphology will precede physiology; we begin with accurate observations of structure, and pass on later to their true significance.

Morphology includes not only the external appearance of the plant, but those minute features which can only be revealed with the aid of a microscope, but which are often of the greatest possible significance. Morphology is also the most useful aid in the *classification* of plants. Just as we can place an animal in the cat-tribe by reference to certain morphological features, so we can place a plant in its appropriate family by similar means.

Under the head of physiology come the essential life-processes of nutrition, growth, reproduction, etc. Physiology joins hands with morphology when we consider such

problems as the relation of a plant to its surroundings (or *environment*), the adaptation of plants to their natural home (or *habitat*), and the evolution of the whole vegetable kingdom. Every phase of these subjects is full of difficulty and full of interest.

Physiology, like morphology, is dependent primarily upon observation of plants in their native habitats; but in this branch of our subject we can also call *experiment* to our aid—i.e. we deliberately place plants under artificial and unnatural conditions, or perform chemical or physical processes upon them, with the idea of exploring more thoroughly their functions and composition.

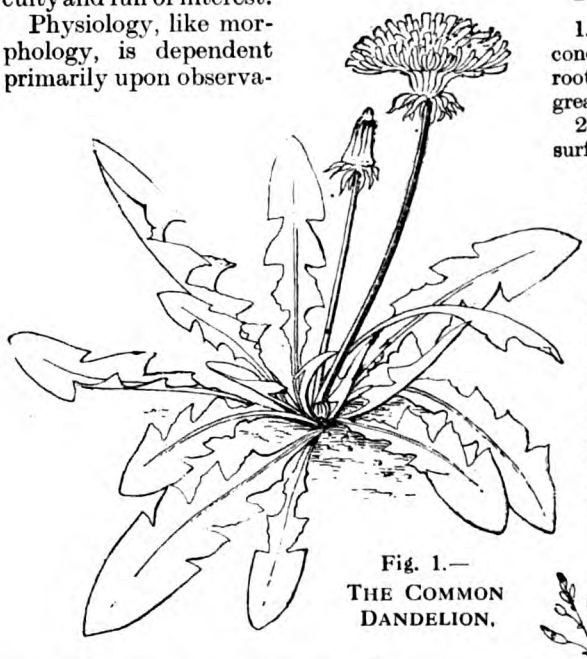


Fig. 1.—THE COMMON DANDELION.

The student should make every effort to perform the experiments described in these lessons. Most of the apparatus needed is of a simple and homely character; that which is not, is referred to in the preliminary lesson on common scientific apparatus in Vol. I. p., 15.

3. A Typical Plant.—Annuals and Perennials.—Let us start our lessons with the examination of a few common plants, treating them in a preliminary and sketchy fashion only.

(*a*) The common *Dandelion* (Fig. 1) is familiar to everyone as an inhabitant of neglected ground everywhere. That it is a plant adapted to hardy and inhospitable conditions is obvious; otherwise, how could it thrive in gravel paths or on rubbish-heaps?—how could it escape as persistently as it does the attentions of the industrious lawn-mower? This physiological reflection calls for a morphological examination for its interpretation.

DEMONSTRATION I

Dig up a Dandelion complete, and observe:

1. The part in the ground is a long tapering cone of solid white material forming the *root*. The root grows straight down into the ground to a great depth, and has few branches.

2. Growing apparently from the root near the surface of the ground is a cluster or rosette of *leaves*, of characteristic shape. [Are they all alike?] Leaves thus arising from the root are spoken of as *radical* leaves.

3. Also arising apparently from the root are two or three of the familiar yellow heads, popularly thought of as the flowers, but in reality forming a cluster of flowers or *inflorescence*. Closer examination will show that these inflorescences start from a point close to the base of a leaf and on the central side of the rosette. Further observation will reveal in the central part of the rosette one or more unopened *buds*, also lying near the bases of leaves; these buds are close to or even below the surface of the ground.

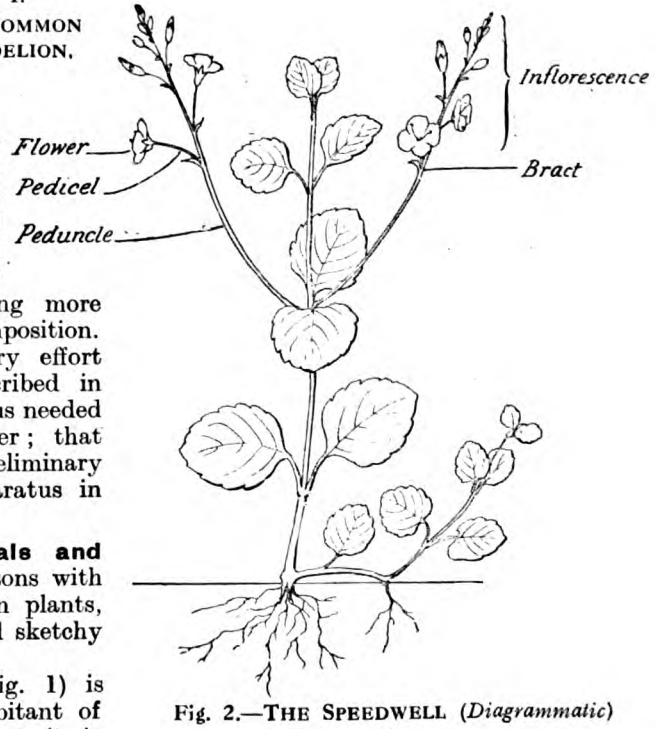


Fig. 2.—THE SPEEDWELL (*Diagrammatic*) **is a perennial like the Dandelion, from which it differs in almost every other detail. No sign of it is visible above ground during winter; a, small bud provides for the new growth.**

More detailed examination will have to be made later on; but at present the student is urged to make a sketch, similar to Fig. 3, of his own observations, showing the relation between the root, the leaves, the flower-groups and the buds. Other observations that can be made from day to day include those connected with the closing of the flowers at night, the visits of insects and the final fate of the heads. Do Dandelions growing on a lawn differ in any way from those growing in an open meadow? Can the questions with which we started be answered now?

If the Dandelion be examined in the winter when it is showing no flowers, a small bud, or perhaps more than one, will be found just below the surface of the ground. From this bud will proceed new leaves and flower-heads next season. Hence the Dandelion is a *perennial*, its individual life persisting from one year to the next.

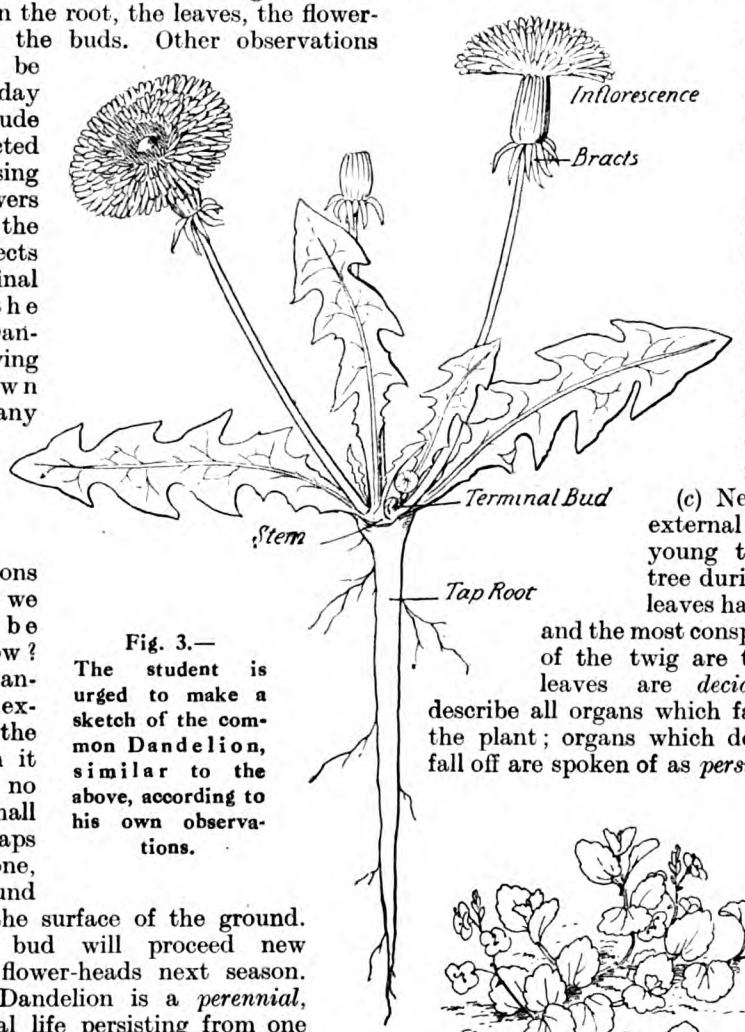


Fig. 3.— The student is urged to make a sketch of the common Dandelion, similar to the above, according to his own observations.

(*b*) The *Germander Speedwell*, or Bird's-eye, is a familiar wild flower in our meadows (Fig. 4), although its blue flowers are not particularly conspicuous. Observation shows that it differs from the Dandelion in almost every detail.

Demonstration II

Taking the parts of the Speedwell above ground only, we note:

1. It has a long *stem* which is at first inclined to creep but afterwards ascends.
2. The leaves arise in pairs from the stem, and the successive pairs are at right angles. This arrangement of leaves is known as *decussate*.
3. The inflorescences arise on the stem at the same point as the leaves arise, i.e. in the *axil* of the leaf, the angle between the leaf and the stem.
4. The inflorescence consists of a long stalk (*peduncle*), from which the flowers arise at intervals. Each flower has a short stalk (*pedicel*). The older flowers are at the base of the inflorescence.

Like the Dandelion, the Speedwell is a perennial, but no sign of it is visible above ground during the winter. A small bud provides for its new growths next year.

(*c*) Next examine the external features of the young twig of a *Lime* tree during winter. The leaves have all fallen off, and the most conspicuous features of the twig are the buds. The leaves are *deciduous*, as we describe all organs which fall off the plant; organs which do not fall off are spoken of as *persistent*.

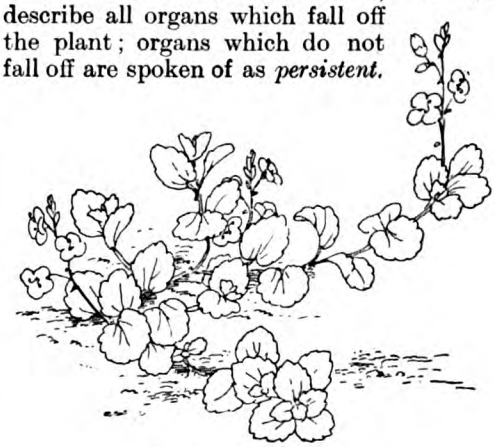


Fig. 4.—THE SPEEDWELL.

Demonstration III

Examining the Lime twig, we now note (Fig. 5):

1. There is a bud at the end of the twig, called the *terminal bud*. Working from the apex, we notice a number of buds on the sides of the twig; these are known as *lateral buds*.
2. Below each bud, observe the very definite mark or scar; these scars were left by the falling leaves, and are hence known as *leaf-scars*. Notice that all the scars are of the same shape, and that there is one scar below each bud. Hence *the*

buds were formed always in the axils of the leaves.

3. The leaves in the lime were obviously not developed in opposite pairs as in speedwell, or in clusters as in dandelion, but singly: such arrangement of the leaves will be described hereafter as *alternate.*

4. Still following the twig downward from its apex, we come to a group of horizontal scars close together. These are the *bud-scale scars*, which were left by the outer scales of the bud when they were thrown off on the opening of the bud. They therefore mark the position of the terminal bud of last year, and define for us the amount of one year's growth.

5. Below the bud-scale scars we notice no more lateral buds on the main twig; but, instead of them, we see a number of short branches, each with its terminal and lateral buds. At the base of these branches we notice the bud-scale scars, which show that they were developed from the lateral

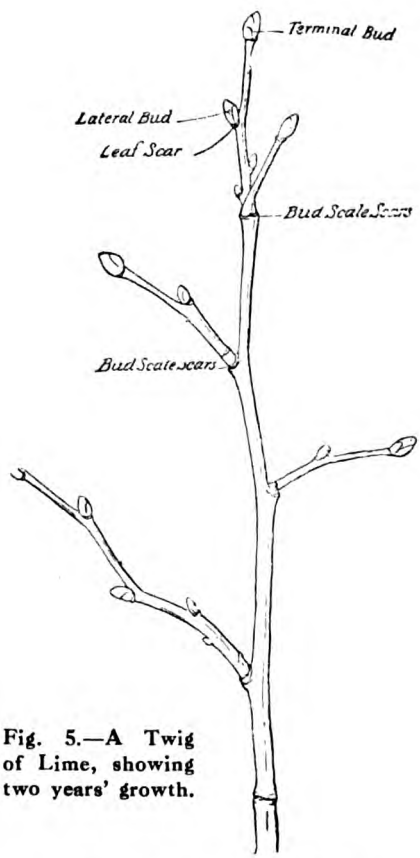


Fig. 5.—A Twig of Lime, showing two years' growth.

buds of the previous year. Further down the main stem, we notice the bud-scale scars of the terminal bud of the year before last.

The Lime tree is clearly a perennial with deciduous leaves; but it is different from the Dandelion and Speedwell in the fact that its stems are persistent and its buds protected by special scales. Its stems, moreover, become woody and continue to grow in thickness from year to year. In other words, it is a *tree:* whereas the Dandelion and Speedwell are *herbs.*

A tree has usually only one main trunk,

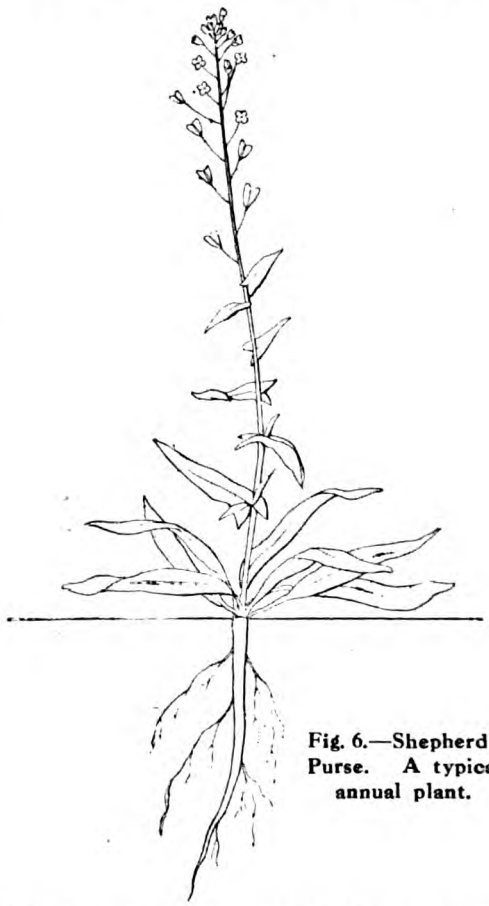


Fig. 6.—Shepherd's Purse. A typical annual plant.

which is easily distinguishable from even its largest branches. A woody plant which has apparently no single main trunk, but a number of more or less equal branches springing from near the ground-level, is generally called *shrub.* A climbing shrub is often spoken of as a *liane.*

Certain plants, known as *annuals*, have no means of carrying their existence on through the winter. Such plants shed their seeds, and all their parts die, in the autumn. Fig. 6 shows a diagram of the Shepherd's Purse, which may be called a typical annual plant.

A complete flowering plant will have a *root;* a *stem* with or without branches; *leaves*, alternate, opposite or radical; and *flowers*, arranged generally in definite groups called inflorescences, from which the seeds arise.

E. W. E.

Continued from page 91.

LANGUAGES:

***Contributors*:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A.[Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).**

LATIN.—XIX

IT will help you to remember the proper case of any substantive to which a particular preposition is prefixed if you observe that, as a rule, the accusative is used in expressing the idea of motion *to, towards,* or *against,* and the ablative that of rest or position *in, over, under, with,* etc. This distinction is most clearly shown in the prepositions that may govern either case, in accordance with the meaning to be conveyed.

Prepositions

1. Prepositions used with the Accusative only :—

ăd,	*to.*	**ŏb,**	*on account of.*
adversum (-sŭs),	*opposite, towards.*	**pĕnĕs,**	*in the power of.*
antĕ,	*before.*	**pĕr,**	*through.*
ăpŭd,	*near, at the house of.*	**pōnĕ,**	*behind.*
circă, circum,	*around.*	**post,**	*after.*
circĭter,	*about* (of number).	**praetĕr,**	*beside, beyond.*
cĭs, citra,	*on this side of.*	**prŏpĕ,**	*near.*
contra,	*against.*	**proptĕr,**	*on account of.*
ergā,	*towards.*	**sĕcundum,**	*following, in accordance with.*
extra,	*outside of.*	**sŭprā,**	*above.*
infrā,	*below.*	**trans,**	*across.*
intĕr,	*between, among.*	**ultra,**	*beyond, on the farther side of.*
intra,	*within.*		
jūxta,	*beside, nigh.*	**versum (-sŭs),**	*towards.*

2. Prepositions used with the Ablative only :—

ā (ăb before vowels or **h, abs** before **tē),**	*from, by.*	**prae,**	*in front of.*
absquĕ,	*without.*	**prō,**	*before, instead of.*
cōram,	*in the presence of.*	**prŏcŭl,**	*far from.*
cum,	*with.*	**sĭnĕ,**	*without.*
dĕ,	*down from, concerning.*	**tĕnŭs,**	*as far as* (used after its case as **căpĭte tĕnŭs,** *as far as the head,* also with the gen. as **crūrum tĕnŭs,** *as far as the legs*).
ex (ē before consonants),	*out of.*		
pălam,	*in the presence of.*		

3. Prepositions used with either Accusative or Ablative :—

in (with acc.), *into;* (with abl.) *in.*
sŭb (with acc.), *up to;* (with abl.) *below.*
subtĕr, *under* } (used with the abl. only
sŭpĕr, *over* } in poetry)

Cum, *with,* is always used as an enclitic with personal pronouns and usually with relative pronouns, as in **mēcum,** *with me,* **vōbiscum,** *with you,* **quōcum, cum quō,** *with whom.* **Versŭs** also is put after the substantive it governs, as in **Londĭnĭum versŭs,** *towards London.*

Conjunctions

Conjunctions may be divided into two main classes, co-ordinative and subordinative. Those of the first class merely connect words, phrases, clauses, or sentences, which are co-ordinate or similar to each other in grammatical importance. Those of the second class connect subordinate sentences with the principal sentences on which they are dependent.

Co-ordinative conjunctions may be classed as follows :—

1. Connective conjunctions, which simply join words and phrases together—comprising :—

et,		**ĕt . . . ĕt**	*both . . .*
atquĕ, āc (before the consonants only)	*and.*	**quum (cum) . . . tum**	*and.*
-que (enclitic).			
	ĕtiam		
	necnōn		*also.*
	quŏquĕ		

2. Disjunctive conjunctions, which express distinctions, comprising :—

aut, **vĕl, -vĕ** (enclitic) } *or.* **sīvĕ . . . sīvĕ** } *either . . . or.*
seu . . . seu }
nĕc . . . . . nĕc } *neither.*
nĕquĕ . . nĕquĕ }
nē . . . nēvĕ (neu) } *nor.*

3. Adversative conjunctions, expressing opposition, as :—

at, atquī, ast (archaic), **autem**, **sĕd**, **cētĕrum**, **vērum** } *but.*
tămen, *yet, nevertheless.*
vērum, vēro, *but yet, but in fact.*
enimvēro, *but indeed.*

4. Conclusive or illative conjunctions, expressing inference, as :—

ergō, **idcircŏ**, **idĕō**, **igĭtŭr** } *therefore.*
ītăque, *and so, accordingly.*
quārĕ, **quāproptĕr**, **quōcircā** } *wherefore.*

5. Causal conjunctions, as :—

ĕnim, **nam**, **namquĕ** } *for.*

Subordinative Conjunctions

Subordinative Conjunctions, which express conditions, cause, and other such ideas of dependence are used with dependent clauses having the verb either in the indicative or in the subjunctive mood, as follows :—

1. Conjunctions used with the Indicative or Subjunctive.

cum (quum) (with indic.), *when ;* (with subj.) *when, since, although.*
postquam, *after that, since.*
priusquam, **antĕquam** } *before that.*
dōnĕc, **dum**, **quŏăd** } (with indic.), *whilst, as long as ;* (with subj.) *until.*
quŏd, **quiă** } *unless.*
etsi, **ĕtĭamsi**, **tămetsī**, **quamquam** (quanquam) } *although.*
sī, *if.*
ŭt (with indic.), **ŭti** (with subj.) } *when, in order that, that, so that, although.*
dum, **dummŏdŏ** } *provided that.*
nīsĭ, nī, *unless.*

2. Conjunctions used with the Indicative only.

quamquam, *although.*
quŏnĭam, *since.*
quandŏquidem, *since indeed, seeing that.*
simŭlăc, **simŭlatquĕ** } *as soon as.*
ubī, *when.*

3. Conjunctions used with the Subjunctive only.

licĕt, **quamvīs**, **nĕ**, *lest.* } *although.*
quīn, **quōmīnŭs** } *that not.*
quō, *in order that, that.*

Interjections

Interjections are cries or other sounds expressing surprise, anger, derision, or other emotion, and may be divided into two classes, those that are merely natural sounds and those that are abbreviated words or phrases.

The first group comprises :—

ā, āh, *ah !*
eccĕ, **ēn** } *lo ! behold !*
ēiă (hēiă), *come !*
eu, eugē, *bravo !*
heu, cheu, *alas !*
heus, *ho !*
īo, *hurrah !*
ō, *O, oh !*
prō, prōh, *ah ! alas !*
vae, *woe !*

The most important of the second group are the following :—

ăgĕ (ăgō), *come !*
ăpăgĕ (ἄπαγε), *away, begone.*
mactĕ (voc. of **mactŭs**, *magnified*), *bravo ! well done ! go on !*
hercle (hercŭlĕ, herculēs), mehercle (mehercŭlĕ mehercŭlēs) } *by Hercules ! help me, Hercules !*
mĕdiŭs fīdiŭs, *may Jupiter* (the god of faith) *help me !*
mălum, *plague !*
pax, *hush !*
pol edĕpŏl, *by Pollux !*

Gender

The student may have encountered difficulties in determining the gender of nouns, Latin usage differing widely from English and frequently regarding inanimate objects as masculine or feminine. A few general rules will enable one to determine at once the gender of a large number of words.

(1) Nouns clearly denoting males are always masculine and those denoting females always feminine. Many nouns may denote either male or female individuals, and these are by nature neither masculine nor feminine, but common. Such are :—

artĭfex,	*artist.*	**părens,**	*parent.*
cīvis,	*citizen.*	**săcerdōs,**	*priest* or *priestess.*
conjux,	*spouse.*		

(2) The names of months, winds, mountains, rivers, and peoples are masculine. Thus **Liburni,** *the Liburnians,* **Gărumnă,** *Garonne,* **Mōsă,** *Meuse,* **Sĕquănă,** *Seine,* are masculine, together with **Kădŭă,** *the Adriatic.* So are names of some animals, as **lĕpŭs,** *hare,* **mūs,** *mouse,* **nassĕr,** *sparrow,* whilst **aquĭlă,** *eagle,* and **vulpes,** *fox,* are always feminine.

(3) The names of plants and trees, countries, islands, and towns are usually feminine.

(4) Every noun that cannot be declined is neuter, as :—

fās,	*that which is lawful.*	**nihĭl,**	*nothing.*
nĕfās,	*that which is unlawful.*	**instăr,**	*resemblance.*

There are some exceptions to rules 2 and 3, which must be learned by observation. Thus the following names of mountains and rivers are feminine—**Hyblă**, **Aetnă**, **Allĭă**, a river in Latium, **Rhŏdŏpē**, **Albŭlă** (old name of the Tiber), **Styx**. On the other hand, **Pēlĭŏn**, **Gargără** (plur.), **Sōractē**, and a few others are neuter. The following names of plants, countries, and towns are masculine — **acanthŭs**, **aspărăgŭs**, **narcissŭs**, **Pontŭs**, **Delphī**, **Gabĭī**, etc., and many are neuter, as **pavarer**, *poppy*, **pĭpĕr**, *pepper*, **lētŭm**, **Samnĭum**, **Tuscŭlum**, **Praenestē**, etc.

(5) With certain limitations nouns of the first declension, unless like **naută**, *sailor*, and **pŏētă**, *poet*, that denote males, are of the feminine gender.

(6) Nouns of the second declension ending in **-ŭs** or **-ĕr** are masculine, those in **-um** are neuter.

The following exceptions should be noted: **alvus**, *belly*, **cŏlŭs**, *distaff*, **hŭmŭs**, *the ground*, **vannŭs**, *winnowing-fan*; and some words from Greek, as **Arctŏs**, *Great Bear*, **Bălănŭs**, *balsam*, are feminine.

Pĕlăgŭs, *sea*, **Vīrŭs**, *poison*, and **Vulgŭs**, *people*, are neuter.

(7) In the third declension we find nouns of every gender, and the rules that may be formulated have numerous exceptions. Abstract nouns denoting qualities and derived from adjectives, or derived from verbs and denoting action in the abstract, are feminine, as :—

From the adjective.

dīversĭtās,	*diversity.*	**dīversŭs,**	*diverse.*
dīvīnĭtās,	*divinity.*	**dīvīnŭs,**	*divine.*
dulcēdō,	*sweetness.*	**dulcĭs,**	*sweet.*
fortĭtūdō,	*fortitude.*	**fortis,**	*brave.*
virtŭs,	*manliness.*	**vir,**	*man.*

From the verb.

rūmĭnātĭo,	*rumination.*	**rūmĭnō,**	*ruminate.*
subvectĭō,	*conveyance.*	**subvĕhĕrĕ,**	*convey.*
vĭŏlātĭō,	*violation.*	**vĭŏlārĕ,**	*violate.*

Words that have ceased to be abstract, as **multĭtūdō**, *multitude*, from **multŭs**, *much*, and **rĕgĭō**, *region*, from **rĕgō**, *rule*, are also feminine.

(8) Nouns of the third declension ending in **-ō** (except the feminines in **-dō**, **-gō**, and **-ĭō** already mentioned), **-ŏr**, **-ōs**, **ĕr**, in **-ĕs**, **ēs**, and **ĭs**, when the genitive increases, and in **-ēn**, and **-ĕn**, except those in **-mĕn**, which are neuter. Among the exceptions are :—**cărō**, *flesh*, **ēcho**, *echo*, feminine; **ordō**, *order*, **cardō**, *hinge*, **harpăgō**, *grapple*, **margō**, *margin*, **pāpĭlĭō**, *butterfly*, **scīpio**, *staff*, masculine; **marmŏr**, *marble*, **aequŏr**, *plain*, **ădŏr**, *spelt*, **cŏr**, *heart*, neuter; **arbŏr**, *tree*, feminine; **cōs**, *whetstone*, **dōs**, *dowry*, feminine; **ŏs**, *bone*, **ōs**, *mouth*, neuter; **cādāvĕr**, *corpse*, **ĭtĕr**, *journey*, **vēr**, *spring*, etc., neuter; **lintĕr**, *trough*, feminine; **compēs**, **-ēdĭs**, *fetter*, **mercēs**, **-ēdis**, *wages*, **mergĕs**, **-ĭtĭs**, *sheaf*, **quiēs**, **-ētĭs**, *rest*, and others, feminine; and **glūtĕn**, *glue*, neuter.

Exercise 18

Translate into English :—

1. Quae regio in terris nostri non plena laboris ? 2. Ubi ius incertum, ibi ius nullum. 3. E duobus malis minimum est eligendum. 4. Tacitum vivit sub pectore vulnus. 5. Exoriare aliquis nostris ex ossibus ultor. 6. Dummodo sit dives, barbarus ipse placet.

Translate into Latin :—

1. Wise men so far as the beard (is concerned). 2. He attains whatever he aims at (seeks). 3. Fear gave (added) wings to his feet. 4. Either the man is mad or he makes verses. 5. I will either find a way or make one.

Key to Exercise 17

1. At times the worthy Homer nods. 2. Never so little alone as when alone. 3. Soon enough is well enough. 4. A thing much and often inquired into. 5. Our forefathers destroyed Carthage and Numantia root and branch. 6. The antipathies of near relatives are generally the most virulent.

1. Sat pulchra, si sat bona. 2. Bene orasse est bene studuisse. 3. Horas non numero nisi serenas. 4. Vere scire est per causas scire. 5. Qui nimium probat nihil probat. 6. Cave quid dicis, quando, et cui.

E. A. B.

FRENCH.—XIX

An impersonal verb is used only in the third person singular with the pronoun **il**, *it*, as in **il pleut**, *it is raining*. It has no present participle and no imperative.

Conjugation of the Impersonal Verb **pleuvoir**, *to rain*.

Pleuvoir, plu, il pleut, il plut.

PRESENT	PAST INDEFINITE
Il pleut, *it is raining.*	Il a plu, *it has rained.*
IMPERFECT	PLUPERFECT
Il pleuvait, *it was raining.*	Il avait plu, *it had rained.*
PAST DEFINITE	PAST ANTERIOR
Il plut, *it rained.*	Il eut plu, *it had rained.*
FUTURE	FUTURE ANTERIOR
Il pleuvra, *it will rain.*	Il aura plu, *it will have rained.*

Conditional Mood

PRESENT	PAST
Il pleuvrait, *it would rain.*	Il aurait plu, *it would have rained.*

Subjunctive Mood

PRESENT	PERFECT
Qu'il pleuve, *that it may rain.*	Qu'il ait plu, *that it may have rained.*
IMPERFECT	PLUPERFECT
Qu'il plût, *that it might rain.*	Qu'il eût plu, *that it might have rained.*

Infinitive Mood

PRESENT	PAST INDEFINITE
Pleuvoir, *to rain.*	Avoir plu, *to have rained.*
	PAST PARTICIPLE
	Plu (invariable), *rained.*

There are two classes of impersonal verbs, (1) those which are impersonal by their nature, as **il faut**, *it is necessary*, **il neige**, *it is snowing*, **il pleut**, *it is raining*, and (2) active or neuter verbs used in an impersonal sense, as **faire** in **il fait beau**, *it is fine*, **avoir** in **il y a**, *there is* or *there are*, **arriver** in **il est arrivé un malheur**, *a misfortune has occurred.* Examples :—

Il fait beau temps aujourd'hui,	*It is fine weather to-day.*
Il fait chaud, il fait froid,	*It is warm, it is cold.*
Il ne nous sied pas de parler ainsi,	*It does not become you to talk like that.*
Il convient de lui écrire,	*It is advisable to write to him.*

The idiomatic expression **il y a** may be followed by a singular or a plural noun, thus—

Il y a du gibier au marché,	*There is game in the market.*
Il y a des pommes dans votre jardin,	*There are apples in your garden.*

The verb **falloir** is always used impersonally, the English subject of *must, is obliged*, etc., being represented by one of the pronouns **me, te, lui, nous, vous, leur,** which forms the indirect object, and is placed in front of the verb, as in—

Il **me** faut écrire un thème,	*I must write an exercise.*
Où nous faut-il aller ?	*Where must we go?*

Falloir is also used in the sense of *wanting, needing, being under the necessity of having*, as in—

Il me faut un livre,	*I require a book.*
Il lui faut de l'argent,	*He is in need of money.*

The English subject of *must*, in the last sense, is represented in French by the indirect object, after **à**, as in—

Il faut un livre à ma sœur,	*My sister requires a book.*

Valoir mieux, used impersonally, means *to be better ;* **valoir la peine**, to be *worth the trouble* or *worth while.* Examples :—

Il vaut mieux travailler que d'être oisif,	*It is better to work than be idle.*
Cela ne vaut pas la peine de parler quand on n'a rien à dire,	*It is not worth while to speak when one has nothing to say.*

Note that **il y a** with an object expressing time is rendered by *ago*, as in—

J'ai reçu une lettre il y a huit jours,	*I received a letter eight days ago.*
Vous avez acheté une maison il y a un an,	*You bought a house a year ago.*

Verbs impersonal by nature take avoir as their auxiliary, as in—

Il a plu, il a neigé, il a gelé,	*It rained, it snowed, it froze.*

Verbs not impersonal by nature but used occasionally in an impersonal construction keep their proper auxiliary, thus—

Il lui est arrivé un malheur,	*A misfortune happened to him.*
A-t-il fait beau temps le mois passé ?	*Was it fine weather last month ?*
Y a-t-il eu beaucoup de monde ?	*Were there many people there ?*

The past participles of impersonal verbs are always invariable, as in—

Les pluies qu'il y a eu cet été,	*The rain that we have had this summer.*

Miscellaneous Idioms.—Note that the abbreviated replies common in English, consisting of a substantive followed by an auxiliary, or an active verb with no object expressed, as in *Are you coming to my house to-day ? I am ; Have you any books ? I have ;* are not allowable in French, in which the answer must be completely expressed, except of course when a mere affirmative or negative answer is made, **oui** or **non**. Examples :—

Venez-vous chez moi aujourd'hui ?	*Are you coming to my house to-day ?*
Oui, monsieur, je viendrai,	*Yes, sir, I shall come.*
Avez-vous des livres chez vous ?	*Have you books at home ?*
Oui, monsieur, nous en avons,	*Yes, sir, we have.*

The verb **mettre**, *to put*, may be used in the sense of *putting on* (garments) or of *laying* (the cloth) or *setting* (the table), thus :—

Quel chapeau mettez-vous ?	*What hat are you putting on ?*
Votre frère met son habit noir,	*Your brother is putting on his black coat.*
Le domestique va mettre le couvert,	*The servant is going to lay the cloth.*

Ôter has the meanings, *to take off*, *to take away*, *to take out*, as in—

Mon domestique ôte son chapeau,	*My servant takes off his hat.*
Ôtez ce livre de la table,	*Take away that book from the table.*
N'a-t-on pas ôté le dîner ?	*Have they not taken away the dinner ?*

The verb **faire**, *to make*, *to do*, is used before another verb in the sense of *to cause*, *to have* (done), thus—

Votre frère fait-il bâtir une maison ?	*Is your brother having a house built ?*
Vous faites faire des souliers de cuir,	*You are having leather shoes made.*

Similarly, **vouloir** is used with the infinitive **dire**, *to say*, in the sense of *to mean*, thus—

Que voulez-vous dire ?	*What do you mean ?*
Que veut dire votre sœur ?	*What does your sister mean ?*

Devoir, *to owe*, before an infinitive expresses obligation, like the English *ought*, as in—

Je dois lui écrire demain,	*I ought to write to him to-morrow.*
Nous devons y aller demain,	*We are to go there to-morrow.*

The English expression *take place* may be translated by **avoir lieu**, thus—

Cela a lieu tous les jours,	*This takes place every day.*

To hear from is translated by **recevoir des nouvelles de**, thus—

Avez-vous reçu des nouvelles de votre sœur ?	*Have you heard from your sister ?*

To hear of or *about* may be rendered by **entendre parleŕ de**, thus—

Entendez-vous souvent parler de vos amis ?	*Do you often hear of your friends ?*

VOCABULARY

s'apercevoir, *to take notice.*	étudier, *to study.*
appeler, *to call.*	s'éveiller, *to awake.*
apprendre, *to learn.*	geler, *to freeze.*
le brouillard, *the fog.*	la jeunesse, *youth.*
la chasse, *hunting.*	lire, *to read.*
le coucher du soleil, *sunset.*	lorsque, *when.*
	le matin, *morning.*
se coucher, *to go to bed.*	se servir, *to make use* (*of*).
déjeuner, *to breakfast.*	le soleil, *the sun.*
s'endormir, *to go to sleep.*	la tâche, *the task.*
l'étude (f.), *study.*	les vêpres, *vespers.*
le château, *the castle, mansion.*	le couvent, *the convent.*
	le moine, *the monk.*
le bateau à vapeur, *the steamer.*	le mensonge, *the lie.*

Exercise 35

1. Il y avait plus de deux heures que les vêpres étaient finies. 2. Il n'y en a pas beaucoup, mais il y en a. 3. Etait-ce pour mieux voir cette fenêtre dont il m'a parlé ? 4. Il n'y a pas de jeunesse sans la beauté. 5. Mais ce qu'il y avait de certain, c'est qu'elle avait disparu. 6. Il n'en fut pas dit davantage. 7. Je parlais ce matin quand vous êtes entré. 8. Je passais hier quand elle m'a appelé. 9. Je parlais hier à votre père, lorsque votre ami nous rencontra. 10. J'avais déjeuné quand il entre. 11. Dès que j'eus fini ma tâche, je parlais à mon ami. 12. Nous nous couchons tous les jours au coucher du soleil. 13. Je m'endors aussitôt que je me couche. 14. Je m'éveille à six heures du matin. 15. Il ne gèle pas, il fait du brouillard. 16. Cette marchandise s'est-elle bien vendue ? 17. Vos enfants se sont-ils appliqués à l'étude ? 18. Pour apprendre une langue il faut l'étudier. 19. Il me faut lire un bon livre. 20. Combien d'argent faut-il à votre père ?

Exercise 36

1. We gave ourselves trouble. 2. Your cousin has taken a walk. 3. Our friends flattered themselves. 4. Did your sisters sit down ? 5. We noticed that. 6. Has your mother been well ? 7. To whom did your sisters apply ? 8. Are they not mistaken ? 9. We were bored there. 10. What did you use for writing with, mademoiselle ? 11. I used a gold pen. 12. Does it rain this morning ? 13. It is not raining, it is snowing. 14. Are there several people at my house ? 15. Is there no one at church ? 16. Is it cold or warm to-day ? 17. Is it windy or foggy ? 18. Last year I used to go to school every day. 19. When we were in the country, we used to study all day. 20. I was going hunting yesterday morning when we met.

Key to Exercise 33

1. He approached her in terror. 2. I put my head in my hands. 3. When my brain was going round in my skull, I forced myself to think out the horrible situation in which I was involved. 4. Wit is satisfied to shine in sayings that are charming or profound, but quickly spoken. 5. They felt themselves superior to all that they had been in their finest evenings. 6. There they enjoyed an unknown power which hitherto they had never dreamed of. 7. It shows itself more distinctly. 8. The trees rise like clustered columns. 9. They thoroughly deserve it. 10. What are you busy with ? 11. I am engaged with my affairs. 12. How is your father ? 13. I sit down when I am tired. 14. Don't let us sit down, it is too late. 15. What is the price per yard of that cloth ? 16. Is not that lady's name L. ? Is it fine to-day ? 17. The weather is magnificent ; will you not go for a walk ? 18. Do you not go for a ride every morning ? 19. I go to bed early. 20. I rise at daybreak.

Key to Exercise 34

1. Je ne sais comment il s'appelle. 2. Non, madame, elle s'appelle M. 3. Il se porte beaucoup mieux. 4. Ne pouvez-vous pas marcher ? Je suis trop fatigué pour marcher. 5. Je me promène tous les matins. 6. Comment vous promenez-vous ? Quelquefois à pied et quelquefois en voiture. 7. A qui vous adressez-vous quand vous avez besoin d'argent ? 8. Je m'adresse à mon banquier. 9. Ne voulez-vous pas vous asseoir ? 10. Nous vous sommes bien obligés. 11. Vous coupez-vous les doigts ? 12. Je me coupe souvent les doigts quand je taille ma plume. 13. Vous rappelez-vous les malheurs de votre frère ? 14. Je me rappelle ses malheurs. 15. Je ne m'en souviens pas du tout. 16. Nous nous couchons tous les jours au coucher du soleil. 17. Nous nous levons de meilleure heure que vous—au lever du soleil. 18. Le menuisier ne se coupe-t-il pas la main ? 19. De quoi vous occupez-vous ? 20. Nous nous occupons de nos affaires.

E. A. B.

GERMAN.--XVI

For the convenience of the student we shall now give a list—an alphabetical list—of all strong verbs and of the weak verbs which show any irregularity. The first column contains the Pres. Infin., the second the 2nd and 3rd persons sing. of the Pres. Ind. when these change the vowel, the third the 1st person sing. Pret. Ind., the fourth the 1st person sing. of the simple form of the Past Conj., the fifth the 2nd person sing. Imperative when this is different from what it would be if the verb were a weak one, and the sixth the Past Part.

Verbs compounded with prefixes are given in their simple form except in cases where the simple form is not in use.

This list is to be used for reference; the class to which strong verbs belong will not be given in the vocabularies in subsequent lessons, as it is indicated in the last column here.

Remember that the 2nd pers. sing of the Imperative does not take the modification; i.e. it is blaſe, brate, etc.

STRONG AND IRREGULAR WEAK VERBS

1	2	3	4	5	6	7
Backen, *bake*	bäckſt, bäckt	buk	büke	—	gebacken	2b
Befehlen, *command*	befiehlſt, befiehlt	befahl	befähle	befiehl	befohlen	1c
Befleißen (ſich), *apply oneself*	—	befliß	beflifſe		beflifſen	3a
Beginnen, *begin*	—	begann	begänne	—	begonnen	1b
Beißen, *bite*	—	biß	biſſe	—	gebiſſen	3a
Bergen(1), *hide*	birgſt, birgt	barg	bärge	birg	geborgen	1c
Berſten(2), *burst*	birſt, birſt	barſt	bärſte	birſt	geborſten	1c
Bewegen(3), *move*	—	bewog	bewöge	—	bewogen	3e
Biegen, *bend*	—	bog	böge	—	gebogen	3c
Bieten, *offer*	—	bot	böte	—	geboten	3c
Binden, *bind*	—	band	bände	—	gebunden	1a
Bitten, *beg*	—	bat	bäte	—	geboten	1b
Blaſen(2), *blow*	bläſt, bläſt	blies	bliefe	—	geblaſen	2c
Bleiben, *remain*	—	blieb	bliebe	—	geblieben	3b
Bleichen(4), *turn pale*	—	blich	bliche	—	geblichen	3a
Braten, *roast*	brätſt, brät	briet	briete	—	gebraten	2c
Brechen, *break*	brichſt, bricht	brach	bräche	brich	gebrochen	1b
Brennen, *burn*	—	brannte	brennte	—	gebrannt	
Bringen, *bring*	—	brachte	brächte	—	gebracht	
Denken, *think*	—	dachte	dächte	—	gedacht	
Dingen(5), *hire*	—	dung	dünge	—	gedungen	3f
Dreſchen(6), *thresh*	driſcheſt, driſcht	droſch	drö ſche	driſch	gedroſchen	3e
Dringen, *press*	—	drang	dränge	—	gedrungen	1a
Dürfen, *be permitted*	darf, darfſt, darf	durfte	dürfte	wanting	gedurft	
Empfehlen, *recommend*	empfiehlſt, empfiehlt	empfahl	empfähle	—	empfohlen	1c
Eſſen, *eat*	iſſeſt, ißt	aß	äße	iß	gegeſſen	2a
Fahren, *go, drive*	fährſt, fährt	fuhr	führe	—	gefahren	2b
Fallen, *fall*	fällſt, fällt	fiel	fiele	—	gefallen	2c
Fangen, *catch*	fängſt, fängt	fing	finge	—	gefangen	2c
Fechten, *fight*	fichtſt, ficht	focht	föchte	ficht	gefochten	3e
Finden, *find*	—	fand	fände	—	gefunden	1a
Flechten, *twine*	flichtſt, flicht	flocht	flöchte	—	geflochten	3e
Fliegen, *fly*	—	flog	flöge	—	geflogen	3c
Fliehen, *flee*	—	floh	flöhe	—	geflohen	3c
Fließen, *flow*	—	floß	flöſſe	—	gefloſſen	3c
Fragen(7), *ask*	frägſt, frägt	frug	früge	—	gefragt	2b

(1) Another form of Past Conj., bürge. (2) The 2nd pers. sing. Pres. Ind. can have the forms birſteſt, bläſeſt, etc. (3) Weak in the sense of setting in motion physically. (4) Weak in the transitive sense *to bleach*. (5) Bedingen is usually weak. Pret. Ind. and Past Conj.; also dung, dünge. (6) Pret. Ind. and Past Conj.; also draſch, dräſche. (7) Usually weak.

STRONG AND IRREGULAR WEAK VERBS—*Continued*

1	2	3	4	5	6	7
Freſſen, *devour*	friſſeſt, frißt	fraß	fräße	friß	gefreſſen	2a
Frieren, *freeze*	—	fror	fröre	—	gefroren	3c
Gären, *ferment*	—	gor	göre	—	gegoren	3e
Gebären(8), *bring forth*	—	gebar	gebäre	—	geboren	1c
Geben(9), *give*	gibſt, gibt	gab	gäbe	gib	gegeben	2a
Gedeihen, *thrive*	—	gedieh	gediehe	—	gediehen	3b
Gehen(10), *go, walk*	—	ging	ginge	—	gegangen	
Gelingen(11), *succeed*	—	gelang	gelänge	—	gelungen	1a
Gelten(12), *be worth*	giltſt, gilt	galt	gälte	gilt	gegolten	1c
Geneſen, *recover* (intrans.)	—	genas	genäſe	—	geneſen	2a
Genießen, *enjoy*	—	genoß	genöſſe	—	genoſſen	3c
Geſchehen(13), *happen*	geſchieht	geſchah	geſchähe		geſchehen	2a
Gewinnen(14), *win*	—	gewann	gewänne	—	gewonnen	1b
Gießen, *pour*	—	goß	göſſe	—	gegoſſen	3c
Gleichen, *resemble*	—	glich	gliche	—	geglichen	3a
Gleiten, *glide*	—	glitt	glitte	—	geglitten	3a
Glimmen, *glow*	—	glomm	glömme	—	geglommen	3c
Graben, *dig*	gräbſt, gräbt	grub	grübe	—	gegraben	2b
Greifen, *seize*	—	griff	griffe	—	gegriffen	3a
Haben, *have*	haſt, hat	hatte	hätte	—	gehabt	
Halten, *hold*	hältſt, hält	hielt	hielte	—	gehalten	2c
Hängen(15), *hang* (intrans.)	—	hing	hinge	—	gehangen	2c
Hauen, *hew*	—	hieb	hiebe	—	gehauen	2d
Heben(16), *lift*	—	hob	höbe	—	gehoben	3e
Heißen(17), *call*	—	hieß	hieße	—	geheißen	3b
Helfen, *help*	hilfſt, hilft	half	hülfe	hilf	geholfen	1c
Kennen, *know*	—	kannte	kennte	—	gekannt	
Kieſen(18), *choose*	—	kor	köre	—	gekoren	3c
Klemmen(19), *press*	—	klomm	klömme	—	geklommen	3e
Klimmen, *climb*	—	klomm	klömme	—	geklommen	3e
Klingen, *sound*	—	klang	klänge	—	geklungen	1a
Kneifen, *pinch*	—	kniff	kniffe	—	gekniffen	3a
Kommen, *come*	—	kam	käme	—	gekommen	
Können, *be able*	kann, kannſt, kann	konnte	könnte	wanting	gekonnt	
Kriechen, *creep*	—	kroch	kröche	—	gekrochen	3c
Küren, *choose*	—	kor	köre	—	gekoren	3c
Laden, *load, summon*	lädſt, lädt	lud	lüde	—	geladen	2b
Laſſen(20), *let*	läſſeſt, läßt	ließ	ließe	—	gelaſſen	2c
Laufen, *run*	läufſt, läuft	lief	liefe	—	gelaufen	2d
Leiden(21), *suffer*	—	litt	litte	—	gelitten	3a
Leihen, *lend*	—	lieh	liehe	—	geliehen	3b
Leſen, *read*	lieſt, lieſt	las	läſe	—	geleſen	2a
Liegen, *lie*	—	lag	läge	—	gelegen	1d
Löſchen(22), *extinguish*	liſcheſt, liſcht	loſch	löſche	liſch	geloſchen	3e
Lügen, *lie* (tell lies)	—	log	löge	—	gelogen	3c
Meiden, *avoid*	—	mied	miede	—	gemieden	3b
Melken, *milk*	—	molk	mölke	—	gemolken	3c
Meſſen, *measure*	miſſeſt, mißt	maß	mäße	miß	gemeſſen	2a

(8) Pres. Ind.; also gebierſt, gebiert. (9) Pres. Ind.; also giebſt, giebt. (10) Pret. Ind. and Past Conj.; also gieng, gienge. (11) Impersonal. (12) Past Conj.; also gölte. (13) Impersonal. (14) Past Conj.; also gewönne. (15) Pret. Ind. and Past Conj.; also hieng, hienge. (16) Pret. Ind. and Past Conj.; also hub, hübe. (17) Old form of Past Part. gehießen. (18) *See* küren. (19) Usually weak, except the compound Past Part. bekommen. (20) The compound veranlaſſen, *to cause*, is weak. (21) verleiden, *to make unpleasant*, is weak. (22) Usually weak when used transitively.

STRONG AND IRREGULAR WEAK VERBS—*Continued*

1	2	3	4	5	6	7
Mögen, *may, like*	mag, magſt, mag	mochte	möchte	wanting	gemocht	
Müſſen, *must*	muß, mußt, muß	mußte	müßte	wanting	gemußt	
Nehmen, *take*	nimmſt, nimmt	nahm	nähme	nimm	genommen	1c
Nennen, *name*	—	nannte	nennte	—	genannt	
Pfeifen, *whistle* [*on*	—	pfiff	pfiffe	—	gepfiffen	3a
Pflegen(23), *bestow care*	—	pflog	pflöge	—	gepflogen	3e
Preiſen, *praise*	—	pries	prieſe	—	geprieſen	3b
Quellen, *gush* (f)	quillſt, quillt	quoll	quölle	quill	gequollen	3e
Raten, *advise*	rätſt, rät	riet	riete	—	geraten	2c
Reiben, *rub*	—	rieb	riebe	—	gerieben	3b
Reißen, *tear*	—	riß	riſſe		geriſſen	3a
Reiten, *ride*	—	ritt	ritte	—	geritten	3a
Rennen, *run*	—	rannte	rennte	—	gerannt	
Riechen, *smell*	—	roch	röche	—	gerochen	3c
Ringen(24), *wrestle*	—	rang	ränge	—	gerungen	1a

(23) Weak in the sense of *to be wont*. (24) Pret. Ind. and Past Conj.; also rung, rünge.

VOCABULARY

Gegend, w.f., *region*.
Dampf, s.m.2, *steam, vapour*.
Grad, s.m.2, *degree*.
Mal, s.n.2, *time*.
neigen, *to incline*.
Mittelpunkt, s.m.2, *centre*.
furchen, *to furrow*.
Licht, s.n.3, *light*.
werfen, s.1c, *throw*.
perſönlich, *personal*.
reden, *to speak*.
Traum, s.m.2, *dream*.
in Erfüllung gehen, *to be fulfilled*.
Blick, s.m.2, *gaze*.
heften, *to fix*.
leſen, *to read*.
Art, w.f., *kind*.
gewiß, *certain*.
Alter, s.n.1, *age*.
Eindruck, s.m.2, *impression*.
Einfluß, s.m.2, *influence*.
ſuchen, *to seek*.
Gegenſtand, s.m.2, *object*.
geheim, *secret*.
Epo'che, w.f., *epoch*.
ſich widmen, *to devote oneself*.
unbekannt, *unknown*.
Lebensart, w.f., *mode of life*.
Hoffnung, w.f., *hope*.
Nähe, w.f., *neighbourhood*.
liegen, *to lie*.
durchwandern (insep.), *to wander through*.
erhaben, *elevated*.
Gedächtniß, s.n.2, *memory*.
deutlich, *clear*.
erſcheinen, *to appear*.
Wetterleuchten, s.n.1, *sheet lightning*.
ſilberfarben, *silver coloured*.
zurück, adv., *back*.
erlauben, *to allow*.
Rührung, w.f., *emotion*.
hinzuſetzen, *to add*.
Jugend, w.f., *youth*.
anfangen, *to begin*.
geographiſch, *geographical*.
Beſchreibung, w.f., *description*.
fühlen, *to feel*.
Vorliebe, w.f., *preference*.
Klima, s.n., *clime, climate*.
Rechenſchaft, w.f., *account*.
merkbar, *noticeable*.
Entſchluß, s.m.2, *decision*.
inſtinktmäßig, *by instinct*.
Beziehung, w.f., *relation*.
Reiz, s.m.2, *charm, attraction*.
ſtudieren, *to study*.
Furcht, s.f., *fear*.
ſitzend, *sitting, sedentary*.
ſchmerzhaft, *painful*.
entſagen, gov. dat., *renounce*.
Südpol, s.m.2, *south pole*.
ungeduldig, *impatient*.
geſtirnt, *starred*.
Stelle, w.f., *spot, passage*.
berühmt, *celebrated*.
beziehen, s.3c, *refer, apply*.
Luft, s.f.2, *air*.
anfüllen, *to fill up*.
zurückrufen, *recall*.
Commentator w.m., *commentator*.
Breite, w.f., *breadth, latitude*.

Simple and compound verbs which appear in their simple form in the above list of strong verbs (which will be completed in the next Lesson) have not been classified in the foregoing vocabulary.

Exercise 39

Das Kreuz des Südens (Fortſetzung).

Die niedern Gegenden der Luft waren ſeit einigen Tagen mit Dämpfen angefüllt. Wir ſahen erſt in[1] der Nacht vom 4ten zum 5ten Julius[2], im 10ten Grade der Breite, das Kreuz des Südens zum erſten Male deutlich; es war ſtark[3] geneigt und erſchien von Zeit zu Zeit zwiſchen Wolken, deren Mittelpunkt, von dem Wetterleuchten gefurcht, ein ſilberfarbenes Licht zurückwarf. Wenn es einem Reiſenden erlaubt iſt, von ſeinen perſönlichen Rührungen zu reden, ſo ſetze ich hinzu, daß ich in dieſer Nacht einen der Träume meiner erſten Jugend in Erfüllung gehen ſah.[4]

Wenn man anfängt den Blick auf geographiſche Charten[5] zu heften und die Beſchreibungen der Reiſenden zu leſen, ſo fühlt man eine Art Vorliebe für gewiſſe Länder und Klimata[6], von welcher[7] man ſich in einem höheren Alter nicht wohl Rechenſchaft geben kann. Dieſe Eindrücke haben einen merkbaren Einfluß auf unſere Entſchlüſſe, und wir ſuchen uns wie inſtinktmäßig mit den Gegenſtänden in Beziehung zu ſetzen, welche ſeit langer Zeit einen geheimen Reiz für uns hatten. In einer Epoche, wo ich den Himmel ſtudierte, nicht um mich der Aſtronomie zu widmen, ſondern[8] um die Sterne kennen zu lernen, wurde ich von einer Furcht in Bewegung geſetzt, welche denjenigen unbekannt iſt, die eine ſitzende Lebensart lieben. Es ſchien mir ſchmerzhaft, der Hoffnung zu entſagen, die ſchönen Sternbilder zu ſehen, welche in der Nähe des Südpols liegen. Ungeduldig[9] die Gegenden des Aequators zu durch-

wandern, konnte ich die Augen nicht gegen das geſtirnte Gewölbe des Himmels erheben, ohne an das Kreuz des Südens zu denken, und ohne mir die erhabene Stelle des Dante ins Gedächtniß zurückzurufen, welche die berühmteſten Kommentatoren auf dieſes Sternbild bezogen haben.

NOTES:

(1) Note the order of words—first, the adverbial extension of time im . . . Julius, second, the adverbial extension of place, in . . . Breite; and after these the direct object, das Kreuz. (2) Julius, the Latin name, more commonly called Juli. (3) ſtark geneigt, *strongly inclined*, i.e. very low, near the setting. (4) ſah—note the construction with this verb, an accusative with an infinitive, like the English *I saw her dance*. (5) Charten—in modern German this word is written Karte. (6) Klimata; this word, which is strong in the singular, keeps the Greek plural, but the dat. plur. is Klimaten, a mixture of the Greek and German endings. (7) welcher refers to Vorliebe, and is dat. sing. (8) ſondern, as usual after a negative clause. (9) ungeduldig . . . durchwandern; this phrase qualifies ich.

VOCABULARY

princess, Prinzeſſin, w.f.
prince, Prinz w.m.
real, wirklich.
find, finden.
amiss, verkehrt.
discover, herausfinden (sep.).
therefore, infolgedeſſen.
much, ſehr.
terrible, furchtbar.
arise, ſich erheben.
lighten, blitzen, w.
come down (of rain), heruntergießen (sep.).
awful, ſchrecklich.
gate, Pforte, w.f.
open, öffnen, w.
outside, draußen.
run in, hineinlaufen in.
out, hinaus.
pea, Erbſe, w.f.
marry, heiraten, w.
travel over, durchreiſen w (insep.).
world, Welt, w.f.
everywhere, überall.
plenty, Fülle, w.f.
right, recht.
return, zurückkommen (sep.).
depressed, niedergeſchlagen.
storm, Sturm, s.m.2.
thunder, donnern, w.
rain, Regen, s.m.1.
torrent, Strom, s.m.2.
knock, klopfen, w.
tower, Turm, s.m.2.
stand, ſtehen, s.
stream, ſtrömen, w.
toe (of shoes), Schuhſpitze, w.f.
heel, Hacke, w.f.

Exercise 40

THE PRINCESS AND THE PEA

There was once a prince who wanted to marry a princess; but she was[1] to be a real princess. So[2] he travelled all[3] over the world to find one, but everywhere there was something amiss. There[4] were plenty of princesses; but if[5] they were real princesses he could not discover, because there was always something that did not seem quite right. He[6] therefore returned home much depressed, as he wanted so[7] very much to marry a real princess.

One night a terrible storm arose; it thundered and lightened, and the rain came down in torrents; it was quite awful. Just then[8] there came[9] a knock at the gate of the tower, and the old king[10] himself went down to open it.

It was a princess who stood outside. But, good heavens![11] what[12] a state she was in! The water streamed from her hair and clothes, and ran in at the toes of her shoes and out at the heels; but she said she was[13] a real princess.

NOTES:

(1) was to, mußte. (2) So, alſo, must be placed after the verb. (3) All the world; say the whole world. (4) There were (es gab) princesses the plenty. (5) If, meaning whether, ob, followed by the conjunctive mood. (6) He returned therefore very depressed home. (7) So very much, ſo ſehr gern. (8) Then, say at this time. (9) Came a knock; use the impersonal passive of to knock (es) wurde an die Pforte geklopft. (10) The old king went himself down. (11) Good heavens! say great God! (12) In what state was she. (13) Was; use the pres. or simple past conjunctive.

Key to Exercise 37

THE SOUTHERN CROSS

Since we had entered the torrid zone, we had been unable sufficiently to admire the beauty of the southern sky, which revealed to our eyes new constellations as we got farther and farther south (in the measure as we advanced towards the south). You experience a curiously familiar feeling when, on nearing the Equator, and especially if you are passing from one hemisphere to another, you see the stars which you have known from your earliest childhood, getting gradually lower and finally disappearing. Nothing reminds a traveller more vividly of the infinite remoteness (immeasurable distance) of his fatherland, than the sight of a new sky. The grouping of the great stars, some scattered nebulous stars which rival the Milky Way in brilliance, and spaces which are conspicuous (distinguished by) owing to extraordinary blackness, give the southern sky a peculiar appearance. This spectacle stimulates the imagination even of those who, ignorant of (without instruction in) higher science, like to contemplate the dome of heaven, as one admires beautiful scenery or a majestic view. There is no need to be a botanist in order to recognise the torrid zone by the mere sight of it; without having acquired any knowledge of astronomy, without being familiar with the charts of Flamstead and La Caille, you feel that you are not in Europe, when you see the gigantic constellation of the Ship or the phosphorescent clouds of Magellan rising on the horizon.

Key to Exercise 38

BRIEF VON LORD BYRON AN DOKTOR PIGOT

Newport Pagnell,
DEN 2TEN *August*, 1811.

Mein Lieber Doktor!

Meine arme Mutter ſtarb geſtern, und ich bin auf dem Wege von London (der Stadt) um ſie nach der Familiengruft zu begleiten. Ich hörte einen Tag von ihrer Krankheit und den nächſten von ihrem Tode. Gott ſei Dank ihre letzten Augenblicke waren friedlich! Man ſagt mir, daß ſie wenig Schmerzen hatte, und daß ſie ſich ihres Zuſtandes nicht bewußt war. Ich fühle nun die Wahrheit von Herrn Grays Bemerkung, „Daß wir nur eine Mutter haben können." Friede ſei mit ihr!

Ich muß ihnen für den Ausdruck Ihrer Hochachtung danken; und da ich in ſechs Wochen geſchäftlich in Lancaſhire ſein werde, werde ich vielleicht bis Cheſter weitergehen . . . . wenigſtens werde ich es verſuchen. Ich werde den größten Teil dieſes Monats in Newſtead bleiben, wo ich mich freuen werde, nach meiner zweijährigen Abweſenheit im Oſten von Ihnen zu hören.

Ich verbleibe, lieber Pigot,
Ihr ſehr ergebener,
Byron.

M. A. L.

Continued from page 107.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A.[Lond.]).

ARITHMETIC.—XIX

137. Foreign Exchanges. — If a person buys goods in a foreign country, instead of paying for the goods by sending gold (which when coined is called **specie** and when uncoined is called **bullion**), which is a troublesome thing to do, he sends in payment a **Bill of Exchange.** This is an order for the payment of a certain sum, and states the name of the **Drawer** or person who gives the order, the name of the **Payee** or person who is to receive the sum, and the name of the person on whom the bill is drawn. This latter, when he has **accepted** or agreed to pay the bill, is sometimes called the **Acceptor.**

The comparative value of the coins of two countries is estimated by the actual value of metal they contain, and is called the **mint par** value or **mint par of exchange.** In practice, the market price of the coins of different countries varies, and their actual price at any time is known as the **Rate of Exchange,** which may be at par, at a premium, or at a discount.

The Rate of Exchange is influenced by many and various circumstances, both commercial and political.

138. The following is a list of the principal coins of the more important countries:

Country.	*Standard Coin.*	*Par of Exchange.*
United Kingdom	Sovereign	£1
France	Franc	9.51d.
Austria-Hungary	Gulden or Florin	19.985d.
Germany	Mark	11.745d.
Holland	Gulden	19.84d.
Norway, Sweden and Denmark	Krone	13.2d.
Portugal	Milreis	53.278d.
United States	Dollar	49.29d.
Turkey	Pound	18s. 0.8d.

The above countries all use gold as their standard. The countries of the "Latin Union," whose coins are like those of France, though they bear different names, are Belgium, Switzerland, Italy and Greece, while Spain and the Balkan States have a similar coinage.

Formerly most countries used both gold and silver as standard coin, and fixed the ratio of the value of equal weights of the two. During the years preceding the Great War, however, silver fell so much in price that silver coins ceased to be worth their face value, and became only tokens. Hence most countries gave up the double standard, or **bi-metallic** and adopted the **gold standard.** In the United Kingdom silver is only legal tender up to £2.

The following countries have a silver standard:

Country.	*Standard Coin.*
China	Shanghai tael
Japan	Yen
Mexico	Dollar
Russia	Rouble

The value of the above in English money varies with the price of silver.

One of the results of the Great War was an enormous increase in the price of silver, and the fluctuations in value which have occurred have introduced some nice and intricate problems in exchange.

Example:—

Suppose the rate of exchange between London and Paris is 25·01 (i.e. £1 = 25·01 francs), between London and Berlin is 20·50 (i.e. £1 = 20·50 marks), and between Berlin and Paris is 20 francs = 16 marks. If a merchant owes 10,000 francs in Paris, will it be more advantageous to him to pay direct or to transmit the money via Berlin ?

If he pays direct, he will have to pay

$$\frac{£10{,}000}{25{\cdot}01} = £399\ 16s.\ 10d.$$

By transmitting through Berlin, he would pay

$$\frac{10{,}000}{20} \times 16 = 8{,}000 \text{ marks}$$

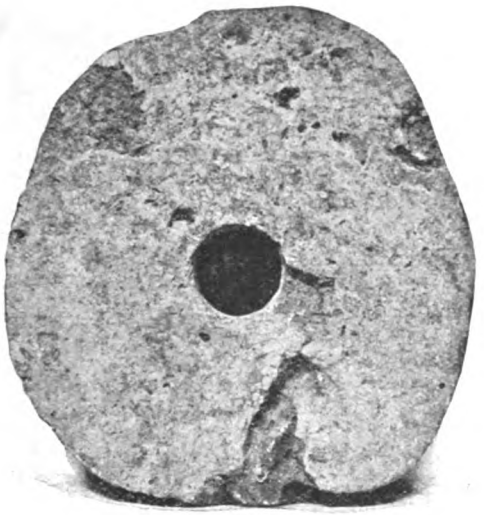
$$= £\frac{8{,}000}{20{\cdot}50} = £390\ 4s.\ 11d.$$

Hence **by transmitting through Berlin he would save £9 12s. approximately.**

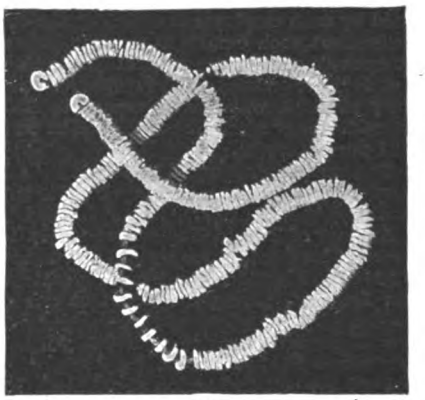
Exercise 46.

(1) A bookseller is allowed by a publisher 20 % discount on the nominal price of books and 5 % on this last amount for cash; he also is charged for 13 copies as 12. The bookseller allows his customers 3d. in the shilling discount on the nominal price. What is the bookseller's profit on cash sales ?

(2) Two sets of tea are mixed in the ratio of 1 : 2 and sold so as to make a profit of 5 %; again they are mixed in the ratio of 2 : 1 and sold so as to make a profit of 10 %; the price per lb. of the mixture is the same in both cases. What is the ratio of their cost prices ?



(1)



(2)

(3)

(4)

(5)

(7)

(8)

(6)

(9)

STAGES IN THE EVOLUTION OF INSTRUMENTS OF EXCHANGE.

(1) Millstone Money. (2) Shell Money. Survivals of the primitive types (1) and (2) may still be found in the S. Pacific. (3) Russian Brick Tea : similar "coins" are used in China. (4) Jadeite Axe Blade. (5) Ring Money—a survival of the Roman bracelet. (6) Razor and Knife Money—the present day coin is a survival of the handle. (7) Silver Larius (Persian). (8) Coin of Constantine the Great, from which (9) The Anglo-Saxon penny was copied.

(3) A company has a pension fund to which the employees contribute at the end of each year 2 % of their salaries, and an amount equal to that contributed by each employee is added by the company. On retirement each employee receives his own and the company's contributions, with simple interest on both at 4 % per annum. If an employee starts with a salary of £400, which is increased to £500 after 10 years, find how much he would receive on retiring after 21 years' service.

(4) One metre being equal to 39·3708 inches, find the percentage error made in assuming 1 kilometre to be equal to $\frac{5}{8}$ mile.

(5) An acre of land in England costs £92 15s. and a hectare of land in France costs 2,150 francs. Express the cost of land in France as a percentage of the cost in England, giving the result to one decimal place.

£1 = 25 francs 1 metre = 1.0936 yd.

1 hectare = 10^4 sq. metres.

(6) Find the cost in London of a Bill of Exchange for

(1) 1,000 francs on Paris at 25.30.

(2) 2,500 marks on Berlin at 20.55.

(3) 5,000 gulden on Vienna at 11.69.

(4) 1,765 roubles on St. Petersburg at $24\frac{1}{2}$ (pence for 1 rouble).

Questions 3, 4 and 5 are from the London Matriculation Examination.

139. Squares and Square Roots. We have already defined a square of a number as the product when that number is taken twice as a factor. The squares of the numbers, 0, 1, 2 . . . 12 can be written down at once, as also those of any fraction whose numerator and denominator are any of the numbers 0, 1 . . . . . 12.

When the squares of larger numbers are to be found, we must either perform the actual multiplication, or, when the number is not too large, we may proceed in the following way.

We know (*see* Vol. I., p. 246, Algebra) that $(a + b)^2 = a^2 + 2ab + b^2$ and that $(a - b)^2 = a^2 - 2ab + b^2$; we therefore express the number to be squared as the sum or difference of two smaller numbers.

Thus: find the square of 75.

$(75)^2 = (70 + 5)^2 = (70)^2 + 2 \times 70 \times 5 + (5)^2 = 4900 + 700 + 25 = \mathbf{5625}.$

Again: find the square of 38.

$(38)^2 = (40 - 2)^2 = (40)^2 - 2 \times 2 \times 40 + (2)^2 = 1600 - 160 + 4 = \mathbf{1444}.$

140. When we find the square root of a number, we find that number which, when multiplied by itself, gives a product equal to the given number. It is clear that we can only find the exact square root of such numbers as are perfect squares, e.g. 1, 4, 9, 64 and so on, but, as we shall show, it is possible to find the square root of any number to any degree of accuracy required.

When a number can be resolved into factors which are themselves all perfect squares, it is easy to find the square root by factorising.

Thus: find $\sqrt{7056}$

$7056 = 12 \times 12 \times 7 \times 7 = 12^2 \times 7^2$

$\therefore \sqrt{7056} = \sqrt{12^2 \times 7^2} = \sqrt{12^2} \times \sqrt{7^2} = 12 \times 7 = \mathbf{84}.$

In cases where the factors are not easily seen by inspection we proceed as follows:—

Since $10^2 = 100$, $100^2 = 10000$, $1000^2 = 1{,}000{,}000$ it is obvious that if a number has 1 digit, its square has either 1 or 2 digits; if a number has 2 digits, its square has 3 or 4 digits; if a number has 3 digits, its square has 5 or 6 digits; and so on.

Hence, if we mark off the digits of a given number in periods of two, beginning with the units, the number of these periods will equal the number of digits in the square root of the given number.

Examples:—

(1) Find $\sqrt{7921}$.

Marking this off in periods of 2 digits each from the unit's place, we have 79,21.

Hence the square root will consist of 2 digits, and may be expressed in the form a + b, where a = No. of tens and b = No. of units. Now we know that $(a + b)^2 = a^2 + 2ab + b^2$ (Vol. I., p. 246, Algebra); and bearing that in mind we proceed thus:

$80^2 = 6400$ and $90^2 = 8100$

$\therefore$ required square root lies between 80^2 and 90^2 and hence in our formula a = 80. We subtract 80^2 from 7921 and this leaves 1521.

Now this remainder must $= 2ab + b^2$ by our formula, i.e. $(2a + b)\,b$.

We have to find b, and $\therefore$ we use 2a = 160 as a trial divisor for 1521 and we obtain as a quotient 9, which is either equal to or greater than the required digit b.

Since $(2 \times 80 + 9)\,9 = 1521$, we see that 9 is the digit required.

The work may be exhibited thus:

$$\begin{array}{rl} & \quad\;\; a \quad\;\; b \\ \sqrt{79{,}21} & \;\big|\; 80 + 9 \\ a^2 = 6400 & \\ 2a + b = 2 \times 80 + 9 = 169 & \;\big|\; 1521 \\ & \;\big|\; 1521 = (2a + b)\,b \\ & \;\;\; \ldots\ldots \end{array}$$

As a rule this process is shortened by omitting the zeros on the right, as in ordinary division, and is written thus

$$\begin{array}{rl} \sqrt{79{,}21} & = 89 \\ 64 & \\ 169 & \;\big|\; 1521 \\ & \;\big|\; 1521 \\ & \;\;\; \ldots\ldots \end{array}$$

(2) Find $\sqrt{16641}$. Here the root will have 3 digits and will therefore be of the form a + b + c, where a are hundreds, b tens and c units.

Now $(a + b + c)^2 = a^2 + b^2 + c^2 + 2bc + 2ca + 2ab = a^2 + (2a + b)\,b + [2\,(a + b) + c]\,c$

$$\begin{array}{rl} & \quad\;\; a \quad\;\; b \quad\;\; c \\ \sqrt{1{,}66{,}41} & = \;\big|\; 100 + 20 + 9 \\ 2a + b & \quad 10000 = a^2 \\ \overbrace{200 + 20} = 220 & \;\big|\; 66{,}41 \\ 2\,(a + b) + c & \;\big|\; 44{,}00 = (2a + b)\,b \\ \overbrace{240 + 9} = 249 & \;\big|\; 22{,}41 \\ & \;\big|\; 22{,}41 = \{2\,(a + b) + c\}\,c \\ & \;\;\; \ldots\ldots \end{array}$$

When using 220 as a trial divisor for 6641 we find the quotient 30, but $(200 + 30) \times 30 = 6900$

which is too great, ∴ we take the digit next below 3, i.e. 2 for our tens.

In practice it comes to this:

Write down the digit whose square is equal to or less than the first period on the left. Multiply this by 2 and use the result as a trial divisor for the remainder when the square of the first digit is subtracted from the given number. Place the quotient thus obtained on the right of the first digit in the answer, and on the right of the trial divisor. Multiply this latter by the second digit and subtract from the first remainder. Multiply the answer so far obtained by 2 and use this as the next trial divisor, and continue thus until there is no remainder. We will now give a rather longer example. All are worked on the same principle, and the student will easily follow the working, if he realises that

$(a + b + c + d + \ldots.)^2 = a^2 + (2a + b)\,b + [2(a + b) + c]\,c + [2(a + b + c) + d]\,d + \ldots.$

(3) Find $\sqrt{315057 \cdot 69}$

$\sqrt{31,50,57 \cdot 69} = \mathbf{561 \cdot 3}$

a^2	$= 25$	
$(2a + b)$	$= 106$	650
		636
$2(a + b) + c$	$= 1121$	1457
		1121
$2(a + b + c) + d$	$= 11223$	33669
		33669
		.....

In the above the zeros on the right have been omitted.

To find the square root of a number which is not a perfect square, we proceed as above till we have reached the last significant figure; then since adding zeros to the right of the decimal point does not alter the value of the number, we continue by adding zeros to the right of the decimal point, until we have found the square root to the required degree of accuracy.

Example:—

Find $\sqrt{253}$ correct to 3 decimal places. We shall find the square root to 4 decimal places, so as to be sure of getting the 3rd place correct.

$\sqrt{2,53 \cdot 00000000} = 15 \cdot 9059$

	1
25	153
	125
309	2800
	2781
31805	190000
	159025
318109	3097500
	2862981

∴ $\sqrt{253} = \mathbf{15 \cdot 906}$ correct to 3 decimal places.

The student is recommended to combine the processes of multiplication and subtraction, as was done in Long Division.

To find the square root of vulgar fractions, it is simplest to express the vulgar fractions as decimals and then find the square root.

Example:—

Find the square root of $\frac{3}{5000}$

$\frac{3}{5000} = \cdot 0006 \quad \therefore \sqrt{\frac{3}{5000}} = \sqrt{\cdot 0006}$

$\sqrt{\cdot 00,06,00,00,00} = \cdot 02449$

	4
44	200
	176
484	2400
	1936
4889	46400
	44001
	2399

∴ $\sqrt{\cdot 0006} = \mathbf{\cdot 0245}$ correct to 4 places of decimals. It is, of course, unnecessary to write down the zeros to the right under the root sign, just as in the division of decimals we do not add them. They were, however, written down in the above to make it clear to the student.

Exercise 47

Find the square root of

(1) 576. (2) 625. (3) 2209. (4) 37249. (5) 527076. (6) 1002001. (7) 7728400. (8) 35307364. (9) 61842496. (10) 99980001. (11) 2. (12) 3. (13) 6290·0761. (14) 478·543.

Answers to be given correct to 4 places of decimals.

Key to Exercise 45

(1) £1600. (2) £2600. (3) £1125. (4) £2025. (5) £1057 6s. (6) £66 9s. 10d. (7) 77⅞; £3085 14s. 3d. (8) 4 per cents. (9) Income increased by £32 5s. (10) £173 17s. 7d. (11) £3123 10s. 7d. in the 5½ per cents. and £6176 9s. 5d. in the 3 per cents. (12) £133875. (13) (*a*) £306 3s. 8d.; (*b*) 29 francs 21 centimes; (*c*) 292 dollars 7 cents. (14) (i) 742·27 francs; (ii) £1 1s. 9d.

M. A. L.

ALGEBRA.—XIX

115. Surds.—An arithmetical surd is usually defined as the root of an arithmetical number which can only be found approximately. Surds are dealt with in the course on arithmetic, and need only be touched upon here.

The algebraic expression $\sqrt{a}$ is usually called a surd, but it *may* have such a value that it is not really a surd. Surds are of the same **order** when the same root of each is required. Thus $\sqrt{3}$ and $\sqrt{a}$ are of the same order, being of the second order or quadratic surds; $\sqrt[3]{b}$ is of the third order, or a cubic surd, while $\sqrt[n]{c}$ is of the nth order.

The student should remember that $\sqrt{a^2}$ stands for $\pm a$, while $\sqrt{4}$ equals 2 unless it is specially written $\pm\sqrt{4}$ which $= \pm 2$.

Any rational quantity can be written in the form of a surd.

Thus $2 = \sqrt{4} = \sqrt[3]{8} = \sqrt[5]{32} = \sqrt[n]{2^n}$.

Similarly $a = \sqrt{a^2} = \sqrt[4]{a^4} = \sqrt[n]{a^n}$.

Again $\sqrt{a} \times \sqrt{b} = a^{\frac{1}{2}} \times b^{\frac{1}{2}} = (ab)^{\frac{1}{2}} = \sqrt{ab}$.

Hence $2\sqrt{3} = \sqrt{4} \times \sqrt{3} = \sqrt{(4 \times 3)} = \sqrt{12}$ and conversely $\sqrt{18} = \sqrt{(9 \times 2)} = \sqrt{9} \times \sqrt{2} = 3\sqrt{2}$, also $\sqrt{32} + \sqrt{48} = \sqrt{(16 \times 2)} + \sqrt{(16 \times 3)} = \sqrt{16}(\sqrt{2} + \sqrt{3}) = 4(\sqrt{2} + \sqrt{3})$.

Any two surds can be expressed as surds of the same order.

Thus $\sqrt[n]{a}$ and $\sqrt[m]{b}$ can be expressed thus—
$\sqrt[n]{a} = \sqrt[mn]{a^m}$ and $\sqrt[m]{b} = \sqrt[mn]{b^n}$.

The product of two surds of the same order can be written down at once, for $\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$.

Hence before finding the product of a number of surds, we must reduce them all to the same order.

Thus $\sqrt{2} \times \sqrt[3]{5} = \sqrt[6]{8} \times \sqrt[6]{25} = \sqrt[6]{200}$.

Similarly before dividing one surd by another we must reduce them to the same order.

As was explained before, when surds occur in the denominator of an expression, the denominator must be rationalised before the arithmetical value is calculated.

Examples :—

(1) Simplify $\dfrac{10\sqrt{6} - 2\sqrt{7}}{3\sqrt{6} + 2\sqrt{7}}$

$$\frac{10\sqrt{6} - 2\sqrt{7}}{3\sqrt{6} + 2\sqrt{7}} = \frac{(10\sqrt{6} - 2\sqrt{7})(3\sqrt{6} - 2\sqrt{7})}{54 - 28}$$

$$= \frac{208 - 26\sqrt{42}}{26} = 8 - \sqrt{42}$$ which is easily calculated.

(2) Simplify $\dfrac{\sqrt{1+x^2} - \sqrt{1-x^2}}{\sqrt{1+x^2} + \sqrt{1-x^2}}$

$$\frac{\sqrt{1+x^2} - \sqrt{1-x^2}}{\sqrt{1+x^2} + \sqrt{1-x^2}} = \frac{(\sqrt{1+x^2} - \sqrt{1-x^2})^2}{2x^2}$$

$$= \frac{2(1 - \sqrt{1-x^4})}{2x^2} = \frac{1 - \sqrt{1-x^4}}{x^2}.$$

116. Surds are said to be similar when they can be expressed so as to have the same irrational factor.

The product and quotient of similar surds are rational.

For, let $x = a\sqrt{b}$ and $y = c\sqrt{b}$

then $xy = abc$ and $\dfrac{x}{y} = \dfrac{a}{c}$

Conversely if $\sqrt{a}$ and $\sqrt{b}$ be two surds whose product is rational, then they must be similar.

For if $\sqrt{a} \times \sqrt{b} = m$ where m is a rational quantity

Then $\sqrt{a} = \dfrac{m}{\sqrt{b}} = \dfrac{m\sqrt{b}}{b}$, a rational multiple of $\sqrt{b}$. Hence both surds are rational multiples of the same root, and $\therefore$ they are similar.

117. If $a + \sqrt{b} = x + \sqrt{y}$, then a must $= x$ and $b = y$, if a, b, x and y are all rational and $\sqrt{b}$ and $\sqrt{y}$ are irrational. Now $a - x + \sqrt{b} = \sqrt{y}$

squaring $(a-x)^2 + 2(a-x)\sqrt{b} + b = y$

$$\therefore 2(a-x)\sqrt{b} = y - b - (a-x)^2 \quad \text{.....A}$$

$$\therefore \sqrt{b} = \frac{y - b - (a-x)^2}{2(a-x)} \quad \text{.....B}$$

Now since a, b, x and y are all rational, $\sqrt{b}$ must be rational, which is contrary to the hypothesis $\therefore$ above equation B is impossible.

It was obtained from A by dividing out by $(a - x)$. But $(a - x)$ is a legitimate divisor unless $a - x = 0$ $\therefore$ in order that B may be impossible, a must $= x$.

But if $a = x$ then $b = y$.

118. If a and b are 2 rational expressions, then $(a + \sqrt{b})$ and $(a - \sqrt{b})$ are called **conjugate quadratic surd expressions.**

Their sum $= 2a$; their product $= a^2 - b$, and these are both rational.

Conversely if the sum and product of two expressions $a + \sqrt{b}$ and $c + \sqrt{d}$ are rational, the expressions are conjugate, for we have

$$\left.\begin{aligned} a + c + \sqrt{b} + \sqrt{d} &= m \text{.....A} \\ (a + \sqrt{b})(c + \sqrt{d}) &= n \text{.....B} \end{aligned}\right\} \text{where}$$

m and n are rational.

To satisfy A we must have
$a + c = m$, and $\sqrt{b} = -\sqrt{d}$.

If we substitute these values in B

$(a + \sqrt{b})(c - \sqrt{b}) = n$

$\therefore ac - b + \sqrt{b}(c - a) = n$ C

$\sqrt{b}$ is irrational $\therefore$ to satisfy C, $c - a$ must $= 0$.
i.e. $c = a$.
$\therefore c + \sqrt{d} = a - \sqrt{b}$.

119. The square root of a binomial expression consisting of a rational quantity and a surd can sometimes be found in a simple form.

Let a and b be rational, and let $\sqrt{b}$ be irrational.

To find $\sqrt{a + \sqrt{b}}$

Let $\sqrt{a + \sqrt{b}} = \sqrt{x} + \sqrt{y}$ ..... (i)

squaring $a + \sqrt{b} = x + y + 2\sqrt{xy}$

$\therefore x + y = a$ ..... (ii)

$2\sqrt{xy} = \sqrt{b}$ ..... (iii)

squaring (ii) $x^2 + 2xy + y^2 = a^2$

squaring (iii) $4xy = b$

subtracting $(x - y)^2 = a^2 - b$

$\therefore x - y = \pm\sqrt{a^2 - b}$ ..... (iv)

Taking the + sign of (iv) in conjunction with (ii) we have

$$x = \frac{a + \sqrt{a^2 - b}}{2}, \qquad y = \frac{a - \sqrt{a^2 - b}}{2}$$

Taking the − sign of (iv) in conjunction with (ii) we have

$$x = \frac{a - \sqrt{a^2 - b}}{2}, \qquad y = \frac{a + \sqrt{a^2 - b}}{2}$$

This gives 4 values of $\sqrt{x}$ and of $\sqrt{y}$, and since $\sqrt{a + \sqrt{b}}$ has only 2 values, we must choose which of these to take. We select those whose signs make $\sqrt{xy}$ of the same sign as $\sqrt{b}$, the sign of the latter being supposed determined.

If $\sqrt{b} > 0$ $\sqrt{x}$ and $\sqrt{y}$ are both positive or both negative

If $\sqrt{b} < 0$ $\sqrt{x}$ and $\sqrt{y}$ have opposite signs.

In either case one value of $\sqrt{x} + \sqrt{y}$ = minus the other value of $\sqrt{x} + \sqrt{y}$.

Hence

$$\sqrt{a + \sqrt{b}} = \sqrt{\frac{a + \sqrt{a^2 - b}}{2}} + \sqrt{\frac{a - \sqrt{a^2 - b}}{2}}$$

This becomes a simple expression if $a^2 - b$ is a perfect square $= c^2$.

Then $\sqrt{a + \sqrt{b}} = \sqrt{\dfrac{a + c}{2}} + \sqrt{\dfrac{a - c}{2}}$.

Examples :—

(1) Find $\sqrt{101 - 28\sqrt{13}}$.

Let $\sqrt{101 - 28\sqrt{13}} = \sqrt{x} - \sqrt{y}$ ..... (i)

then $101 - 28\sqrt{13} = x + y - 2\sqrt{xy}$

$\therefore\ x + y = 101$ ..... (ii)

$2\sqrt{xy} = 28\sqrt{13}$ ..... (iii)

from (ii) $x^2 + 2xy + y^2 = 10201$

from (iii) $4xy = 10192$

subtracting $(x - y)^2 = 9$

$\therefore\ x - y = +3$ or $x - y = -3$.

$x - y = +3$	$x - y = -3$
$x + y = 101$	$x + y = 101$
then $x = 52$	then $x = 49$
$y = 49$	$y = 52$

$\therefore$ if $\sqrt{x} = \sqrt{52} = 2\sqrt{13}$ then $y = \sqrt{49} = 7$, which satisfies (iii)

if $\sqrt{x} = -\sqrt{52} = -2\sqrt{13}$ then $y = -\sqrt{49} = -7$, which satisfies (iii).

In the first case $\sqrt{x} - \sqrt{y} = 2\sqrt{13} - 7$

in the second case $\sqrt{x} - \sqrt{y} = -2\sqrt{13} + 7$.

(2) Find $\sqrt{-9 + 6\sqrt{3}}$

$\sqrt{-9 + 6\sqrt{3}} = \sqrt{\sqrt{3}(6 - 3\sqrt{3})}$

$\sqrt[4]{3}\ \sqrt{6 - 3\sqrt{3}}$

Let $\sqrt{6 - 3\sqrt{3}} = \sqrt{x} - \sqrt{y}$

$6 - 3\sqrt{3} = x + y - 2\sqrt{xy}$

$\therefore\ x + y = 6$ and $2\sqrt{xy} = 3\sqrt{3}$ $\Big\}$ $\therefore\ x^2 + 2xy + y^2 = 36$

$4xy = 27$

$\therefore\ x - y = \pm 3$

Hence $x = \frac{9}{2}$, $y = \frac{3}{2}$ or $x = \frac{3}{2}$, $y = \frac{9}{2}$

Picking our signs correctly

$$\sqrt{x} = \sqrt{y} = \sqrt{\frac{9}{2}} - \sqrt{\frac{3}{2}} \text{ or } -\sqrt{\frac{9}{2}} + \sqrt{\frac{3}{2}}$$

$$\therefore \sqrt{-9 + 6\sqrt{3}} = \sqrt[4]{3}\left(\sqrt{\frac{9}{2}} - \sqrt{\frac{3}{2}}\right) = \frac{\sqrt[4]{3}}{2}\left(3\sqrt{2} - \sqrt{6}\right)$$

Example:—

Find the square root of

$25a^4 + 9b^4 + 4c^4 + 12b^2c^2 - 20c^2a^2 - 30a^2b^2$

This may be written

$(5a^2)^2 - 2 \times (5a^2)(3b^2 + 2c^2) + (9b^4 + 12b^2c^2 + 4c^4)$.

The square root of this is clearly $5a^2 - (3b^2 + 2c^2) = 5a^2 - 3b^2 - 2c^2$.

Now if the expression contains more than two powers of one letter, consider the following:

Let the expression be $(P + Q)^2$ where P stands for certain terms of the expression and Q for all the rest, and where P and Q are both arranged either in ascending or in descending powers of a certain letter. Further suppose the terms of P are known and we have to find the terms of Q.

Subtracting P^2 from $(P + Q)^2$, we get the remainder $2PQ + Q^2 = (2P + Q)Q$.

Owing to the manner in which we have arranged the expression, it is clear that the first term of the remainder Q equals twice the product of the first term of P and the first term of Q.

To obtain the next term of the root, i.e. the first * term of Q, we consequently subtract P^2 from the given expression, and divide the first term of the remainder by twice P.

The first term of the root is obviously the square root of the first term of the expression; thus initially P consists of the first term of the root only, and Q equals all the rest. Having obtained the first term of Q by the method of subtraction and division described above, we get P^1 which consists of the first and second terms of the root, while the remaining terms Q^1 will number one term less than Q. This process is repeated until the whole root is found.

Examples:—

Find the square root of

$$x^6 + 2x^5 + 3x^4 + 4x^3 + 3x^2 + 2x + 1 \quad (x^3 + x^2 + x + 1)$$

$(x^3)^2 = x^6$

$(x^3 + x^2)^2 = x^6 + 2x^5 + x^4$

$(x^3 + x^2 + x)^2 = x^6 + 2x^5 + 3x^4 + 2x^3 + x^2$

$(x^3 + x^2 + x + 1)^2 = x^6 + 2x^5 + 3x^4 + 4x^3 + 3x^2 + 2x + 1$

120. Square root of algebraic expressions.

From the identity $(a \pm b)^2 = a^2 \pm 2ab + b^2$ we may write down by inspection the square root of a trinomial expression which is a perfect square.

Thus to find the square root of $9x^2 - 12xy + 4y^2$ the square roots of the first and last terms are $\pm 3x$ and $\pm 2y$. As the middle or product term is negative we must choose opposite signs, hence the square root is $\pm(3x - 2y)$.

In future of the two square roots we shall deal with that one in which the first term is positive, it being understood that the other root also exists.

If an expression contains only two powers of one particular letter, we may arrange it in the form of a trinomial. Thus $x^2 + y^2 + z^2 + 2yz + 2yx + 2xy$ may be written $x^2 + 2x(y + z) + (y^2 + 2yz + z^2)$.

The square root of this is seen to be $x + (y + z)$ i.e. $x + y + z$.

The square root of the first term is x^3.

Subtracting the square of x^3 we have as the first term of the remainder $2x^5$. Dividing $2x^5$ by $2x^3$ (twice the first term) we get x^2, as the second term of the root.

Subtracting $(x^3 + x^2)^2$ from the expression, we get as the first term of the remainder $2x^4$. Dividing $2x^4$ by $2x^3$ again, we get x, the third term of the root.

Subtracting $(x^3 + x^2 + x)^2$ from the expression, we get as the first term of the remainder $2x^3$, and dividing $2x^3$ by $2x^3$ we get 1, the last term of the root.

Subtracting $(x^3 + x^2 + x + 1)^2$ from the expression, we find there is no remainder, and hence $x^3 + x^2 + x + 1$ is the required square root.

The following example shows a slightly different

* Here and to the end of the next paragraph the first term will be the highest or the lowest power, according to the manner of arrangement.

mode of writing out the working; it is clearly based on the same principles.

(2) Find the square root of

$$x^4 - 2x^3 + 5x^2 - 6x + 8 - 6x^{-1} + 5x^{-2} - 2x^{-3} + x^{-4}$$

$$(x^2 - x + 2 - x^{-1} + x^{-2})$$

$$\begin{array}{r|l} & x^4 \\ 2x^2 - x & -2x^3 + 5x^2 \\ & -2x^3 + x^2 \\ 2x^2 - 2x + 2 & 4x^2 - 6x + 8 \\ & 4x^2 - 4x + 4 \\ 2x^2 - 2x + 4 - x^{-1} & -2x + 4 - 6x^{-1} + 5x^{-2} \\ & -2x + 2 - 4x^{-1} + x^{-2} \\ 2x^2 - 2x + 4 - 2x^{-1} + x^{-2} & 2 - 2x^{-1} + 4x^{-2} - 2x^{-3} + x^{-4} \\ & 2 - 2x^{-1} + 4x^{-2} - 2x^{-3} + x^{-4} \end{array}$$

Here again we subtract the square of x^2; we write down on the left twice x^2 and add the second term of the root $-x$, obtained by dividing the first term of the remainder $-2x^3$ by $2x^2$; we then multiply $2x^2 - x$ by $-x$ and subtract the product. Next we write on the left twice $x^2 - x$ and proceed as above.

If an expression is not a perfect square we may find as many terms of its square root as we please.

Thus $\sqrt{x^2 + 2x}$ to 2 terms is $x + 1$, and $\sqrt{1 + 2x - 2x^2}$ to 4 terms is $1 + x - \frac{3}{2}x^2 + \frac{3}{2}x^3$.

The student can easily verify these statements.

121. Cube root of an expression

From the identity $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ we see that the cube root of any perfect cube consisting of four terms arranged in ascending or descending powers of some letter, may be written down by inspection.

Examples:—

(1) Find the cube root of $a^3 + 8b^3 + c^3 + 6a^2b + 3a^2c + 12ab^2 + 3ac^2 + 12abc + 12b^2c + 6bc^2$.

This may be arranged thus:

$a^3 + 3a^2(2b + c) + 3a(2b + c)^2 + (2b + c)^3$

and its cube root is $a + 2b + c$.

Suppose we have to find the cube root of $(P + Q)^3$, where P stands for any number of terms of the root and Q for the rest, and where P and Q are both arranged in ascending or descending powers of a certain letter. Further suppose the terms of P are known, and we have to find the terms of Q.

Subtracting P^3 from $(P + Q)^3$ we get the remainder $(3P^2 + 3PQ + Q^2)Q$.

Owing to the manner in which we have arranged the expression, it follows that the first term of the remainder equals 3 times the product of the square of the first term of P and the first term of Q. To obtain the next term of the root, we subtract the cube of that part which is already found from the whole expression, and divide the first term of the remainder by three times the square of the first term of the root.

This method (which in principle is the same as that employed to find the square root) will, by repeated application, give the successive terms of the root.

(2) Find the cube root of

$$a^9 - 3a^8b + 9a^7b^2 - 22a^6b^3 + 36a^5b^4 - 67a^4b^5 + 71a^3b^6 - 83a^2b^7 + 54ab^8 - 27b^9.$$

There are 10 terms, and the cube root will therefore have 4 terms.

The first term of the root will be $\sqrt[3]{a^9} = a^3$

The last term of the root will be $\sqrt[3]{-27b^9} = -3b^3$

The second term of the root will be $-\frac{3a^8b}{3(a^3)^2} = -a^2b$

The term before the last will be $\frac{54ab^8}{3(-3b^3)^2} = 2ab^2$

Hence, if the expression is a perfect cube, its root will be $a^3 - a^2b + 2ab^2 - 3b^3$.

Exercise 27

Simplify the following

(1) $\frac{25\sqrt{3} - 4\sqrt{2}}{7\sqrt{3} - 5\sqrt{2}}$. (2) $\frac{1}{\sqrt{8} + \sqrt{3}} + \frac{1}{\sqrt{8} - \sqrt{3}}$.

(3) $\frac{2\sqrt{a+b} + 3\sqrt{a-b}}{2\sqrt{a+b} - \sqrt{a-b}}$.

(4) $\frac{3 + \sqrt{6}}{5\sqrt{3} - 2\sqrt{12} - \sqrt{32} + \sqrt{50}}$.

(5) $\frac{1}{\sqrt{6} + \sqrt{21} - \sqrt{10} - \sqrt{35}}$.

(6) $\frac{1}{\sqrt[3]{2} - 1} + \frac{1}{\sqrt[3]{2} + 1}$. (7) $\sqrt{13 + 2\sqrt{30}}$.

(8) $\sqrt{47 - 4\sqrt{33}}$. (9) $\frac{\sqrt{(5 + 2\sqrt{6})} - \sqrt{(5 - 2\sqrt{6})}}{\sqrt{(5 + 2\sqrt{6})} + \sqrt{(5 - 2\sqrt{6})}}$.

Find the square roots of

(10) $x^2 - 10xy + 25y^2$. (11) $6acx^5 + 4b^2x^4 + a^2x^2 + 9c^2 - 12bcx^3 - 4abx^7$. (12) $\frac{a^4}{64} + \frac{a^3}{8} - a + 1$.

(13) $\frac{25x^2}{y^2} + \frac{y^2}{25x^2} - 20\frac{x}{y} + \frac{47}{5x} + 2$.

Find the cube roots of—

(14) $1 - 6x + 21x^2 - 44x^3 + 63x^4 - 54x^5 + 27x^6$.

(15) $216 + 342x^2 + 171x^4 + 27x^6 - 27x^5 - 109x^3 - 108x$.

Key to Exercise 26

(1) $\frac{1}{5}$. (2) 16. (3) $\frac{1}{a^{\frac{2}{3}}b^{\frac{1}{2}}}$. (4) 1. (5) $x^{\frac{7}{2}} - 3x^{\frac{5}{2}} + 5x^{\frac{3}{2}} - 7x^{\frac{1}{2}} + 7x^{-\frac{1}{2}} - 5x^{-\frac{3}{2}} + 3x^{-\frac{5}{2}} - x^{-\frac{7}{2}}$. (6) $x^4 + 1 + x^{-4}$.

(7) $x + y$. (8) $2(x^{\frac{3}{2}} - y^{\frac{3}{2}})$. (9) (a) $a^{\frac{5}{2}} + a^2b^{\frac{1}{2}} + a^{\frac{3}{2}}b^{\frac{3}{2}} + ab^4 + a^{\frac{1}{2}}b^{\frac{15}{2}} + b^{\frac{20}{3}}$. (b) $(x^{\frac{3}{2}} + y^{\frac{3}{2}} + z^{\frac{3}{2}} - y^{\frac{1}{2}}z^{\frac{1}{2}} - z^{\frac{1}{2}}x^{\frac{1}{2}} - x^{\frac{1}{2}}y^{\frac{1}{2}})\{(x + y + z)^2 + 3x^{\frac{1}{2}}y^{\frac{1}{2}}z^{\frac{1}{2}}(x + y + z) + 9x^{\frac{2}{3}}y^{\frac{2}{3}}z^{\frac{2}{3}}\}$.

M. A. L.

Continued from page 112.

ART AND MUSIC:

***Contributors*:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).**

MUSIC.—V

WE have now reached a perhaps difficult stage in the examination of the phenomena of the musical scale. During our process of dividing the piano string into segments, and observing that the higher the note the shorter the string, and the faster the rate of vibration, we learned the mathematical rule that the number of vibrations varies "inversely" as the length of the string—i.e. half the string's length ($\frac{1}{2}$) gives two vibrations to one, expressed by the fraction $\frac{2}{1}$, and so on.

Arithmetical Relationship of A B C

By proper working with the figures of the following table we shall get some interesting results:

(*a*) Relative length of chord :—

C	D	E	F	G	A	B	C
1	$\frac{8}{9}$	$\frac{4}{5}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{3}{5}$	$\frac{8}{15}$	$\frac{1}{2}$

(*b*) Relative number of vibrations :—

C	D	E	F	G	A	B	C
1	$\frac{9}{8}$	$\frac{5}{4}$	3	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2

The second line (*b*) of the above table must be interpreted thus: In order to produce the second note D nine vibrations must be made in the same time required by the eight which give the note C; to obtain E five vibrations must be made in the time required by four of the first note C, and so on with the other intervals.

We will now do a little simple and interesting calculation with these figures to see what arithmetical relation they bear to each other.

Sounds Shown in Figures

Let us divide—

$1 \div \frac{9}{8} = \frac{9}{8}$ between C and D.

$\frac{9}{8} \div \frac{5}{4} = \frac{40}{36} = \frac{10}{9}$ " D and E.

$\frac{5}{4} \div \frac{4}{3} = \frac{16}{15} = \frac{16}{15}$ " E and F.

It will thus be seen that there are three different intervals between the first three notes after C, namely $\frac{9}{8}, \frac{10}{9}, \frac{16}{15}$. These, indeed, are all the intervals that occur in the scale at all, and they occur in the same order in each successive octave, as shown at bottom of this page :—

The Three Accurate Intervals

The interval $\frac{9}{8}$, the largest interval in the scale, is called a *major* tone; $\frac{10}{9}$ is called a *minor* tone; and $\frac{16}{15}$ is called a semitone, though it is greater, as you can see, than one-half of either a major or a minor tone.

The interval $\frac{16}{15}$ is frequently spoken of as a diatonic semitone, and the difference between a major tone and a diatonic semi-

	C	D	E	F	G	A	B	C′	D′	E′	F′	G′	A′	B′	C′
Vibrations.	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2	$\frac{18}{8}$	$\frac{10}{4}$	$\frac{8}{3}$	$\frac{6}{2}$	$\frac{10}{3}$	$\frac{30}{8}$	$\frac{32}{8}$
Name of Interval	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
*		$\frac{9}{8}$	$\frac{10}{9}$	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{10}{9}$	$\frac{9}{8}$	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{10}{9}$	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{10}{9}$	$\frac{9}{8}$	$\frac{16}{15}$

(4).

* Interval obtained by dividing each note by that which precedes it.

From the painting by Watteau

THE MUSIC PARTY.

tone is called a chromatic semitone. We can show this interval by subtracting the two fractions $\left(\frac{9}{8} - \frac{16}{15}\right)$ thus: $\frac{9 - 16}{8 \times 15} = \frac{7}{120}$

There are two other small mathematical intervals, viz., the difference between a minor tone and a diatonic semitone, and the difference between the major tone and the minor tone. This latter is called by musicians a "comma," and is represented by $\frac{9}{8} - \frac{10}{9} = \frac{1}{72}$. We might be disposed to smile at a man who professed to have so keen an ear as to be able to distinguish the difference caused by the extra vibration; but quite a number of players are able to do so, and a first-rate piano-tuner will be sensitive to smaller differences.

When music was vocal, or was accompanied by instrument playing in thirds (colloquially called "seconds"), fourths, or fifths, a certain important feature of the monochord scale was not brought into undue prominence.

Thirds of a Flat Octave

We have seen that whilst C or any foundation Doh makes 4 vibrations, the major third (Mi) must make 5 vibrations; and if we use this higher note for a Doh, the major third of this note again must make 5 vibrations to 4, and so with the next. By means of these thirds we ought to have reached the octave of the C we started from; but what we have really reached is this:—

$$\frac{5}{4} \text{ of } \frac{5}{4} \text{ of } \frac{5}{4} = \frac{125}{64}$$

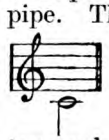
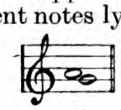
i.e. 125 vibrations for octave C′ against 64 of the lower C; but the true octave requires $\frac{128}{64}$ or $\frac{2}{1}$. Now we can understand, seeing how trained ears are sensitive even to a "comma," that such a flat interval as $\frac{125}{64}$ would be unbearable to any person.

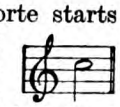
What they did in the old days was to keep their octaves pure, and not to use those keys for harmony which would show up the "wolves" lurking amongst the thirds. The introduction of modern harmony was due to the selection of the key of C, with its leading note B, that seems to reach up to its natural resting place; and it was the desire of composers and players to use, in every other key, the harmonies founded on the intervals of the key of C that led to the introduction and adoption of the ingenious device by which the difficulty of the thirds, fifths, and octaves has been overcome.

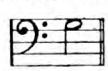
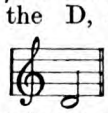
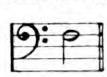
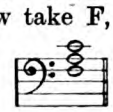
In order to obtain a perfect octave and give us twelve so-called equal semitones, the extra vibrations have been distributed over the other notes of the scale. Mathematically, none of the intervals is absolutely true; but they are sweet to ears accustomed to them, and, as we have explained, any one of the white or black notes of a piano or organ, within what is called the cycle of keys, can be made Doh, and a piece of music or accompaniment put straight into the key—a thing which was impossible before what is called "equal temperament" was adopted.

The Piano Tuner at Work

How "equal temperament"—i.e. the production of twelve fairly equal semitones—is obtained upon the household piano is probably worth the telling. No doubt the "tuner" has been watched at his work by some with a little mystification and very much interest.

Usually the tuner of a pianoforte starts by getting the three strings of C′ in perfect unison with his pitch-pipe. Then he sets the note C,  the octave below in perfect tune with the upper C. When the two different notes lying close together like  are struck simultaneously, and you listen attentively, you will hear "waves" or "beats." It is these "waves" which guide the tuner in his tempering. They are the pulsings of the vibrations of the strings beating against each other, and the nearer the notes approach concord the less noticeable the beats become, till they practically disappear.



After the tuner has got his middle C in perfect tune, he proceeds to tune the G below or beat  (the fourth below) a wave *flat*. From this G he tackles the D, a fifth above, next to middle C, and makes this a wave flat. From the D he descends to A, a  wave flat. From middle C the tuner will now take F, a shade sharp, and he has now got in tune the triad, making the   chord F, A, C.

From F the tuner will proceed to B♯, which must be a wave sharp, and now all notes of the two scales, C and F, are in tune except E and B♭. The E is made from A, and the B♭ from E.

Then by fourths and fifths all the black notes can be brought in tune, and by taking octaves upwards and downwards, and testing the chords, your piano is tuned in "equal temperament."

And when you learn a song by its music you are no longer singing the mathematical scale of the pagans, or even of mediæval or of Shakespeare's England, but the modern—or comparatively modern—and more useful scale which was the outcome of the growth of musical knowledge and of the needs of the great composers and performers. H. G.

BOOK ILLUSTRATION.—II

In the last lesson there were some notes upon the illustration of travel books, mentioned as perhaps the most satisfying form of illustration. Two other kinds were particularised—the pictures for children's books, and the illustration of fiction.

The illustration of books for children provides, no doubt, the widest field in the whole of this class of art. There are simple A B C books, books of animals, fairy stories and comic books. It is needless to add, or should be, that drawings for this purpose should be simple and accurate. Children are the most rigorous critics in the world, particularly if they happen to be of an observant nature. Therefore your cows and horses must look like cows and horses. But how many children's books are mere blots of vivid and irresponsible colour, unnatural, inartistic, wrong, bad? Children are not always observant, and if the book, whatever it is, happens to take their fancy, they may gather all sorts of wrong conclusions from it.

Good colouring, again, is just as attractive to children as bad colouring, but some illustrators of the baser sort persist in believing that bright colours as such are what children require. This is not so, or need not be so. There are endless opportunities for the introduction of the most vivid colours obtainable, only they should be coincident to their proper forms.

Fairy stories give an admirable chance to the artist who is interested in grotesques. When I say grotesques I do not mean badly-shaped beasts or buildings, but symmetrical things, in the composition of which, however, the imagination has very free play. Dragons and other mythical beasts can be made either in line or colour extremely beautiful, and they should be. If they are to be ferocious or evil they can at least be attractively drawn, so that the very lines that compose them draw the child's attention to their power, virility and expressiveness.

A B C books, of which there seems to be no end at all—each recurring Christmas brings in a fresh batch from various publishers—are rich with possibilities of which advantage is seldom taken. Again, in comic books there is not the smallest need for ugliness in caricature. Elephants in trousers and monkeys dressed as able-seamen and such-like commonplaces can be rendered attractively and not cheaply, as they usually are.

And cover designs for books of children's verse and story-books again give plenty of opportunity for the skilled use of good bright colour, good line and bold, wide treatment. It is not meant that in the illustration of books for children it is perpetually necessary to be improving and instructive—there is and always has been far too strong an inclination in that direction—but you can at least contrive that the children should not be positively taught wrong ideas and be instilled with inaccurate ideals. Soundness of drawing, that is particularly to say *line*, and the judicious use of good colour whether light or subdued, is what is chiefly required.

George Cruikshank

The skilled craftsman can make excellent use for decorative purposes of animals, thus mingling with his designs the triumphs of Nature, the greatest of all artists. On the opposite page are shown some of M. Joseph Gauthier's delightful designs, utilising the Hornbill, the Toucan, the Humming Bird and a Beetle, and suppressing certain details while accentuating others, he has achieved a curiously Japanese effect.

One of the celebrated book-illustrators of the Victorian era was the artist and caricaturist, George Cruikshank (1792-1878). His drawings expressed very happily his droll and whimsical spirit. He honestly tried to elucidate the text he had to illustrate, and in this he was generally successful. In composition he acquired remarkable skill, especially, for example, the groupings of crowds. The fight in the churchyard in *Tom Jones* (Henry Fielding) may be mentioned as an instance.

His work is very prolific. He made etchings and engravings to Goldsmith, Fielding, Le Sage, Cervantes, Sterne, Defoe, Sir Walter Scott, and Dickens.

His illustrations of *Oliver Twist* are perhaps the best-known. J. G. B. L.

From designs by Joseph Gauthier.

ANIMALS FOR DECORATIVE PURPOSES

in the hands of skilled craftsmen provide excellent designs. Above are shown the hornbill, the toucan, the humming bird, and a beetle; and the artist, by suppressing certain details and accentuating others, has secured a strikingly Japanese effect.

Continued from page 120.

BUSINESS AND COMMERCE:

Contributors **:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).**

COMMERCIAL TRAINING.—XVIII

INSURANCE is one of the most important of matters in connection with the transport of commercial commodities ; and particularly when they have to be carried by sea.

At this stage, therefore, it will be well to specify further details with regard to the question of insurance as applied to a cargo shipped from this country.

It has already been explained that insurance upon export goods is arranged either by Lloyd's, a group of underwriters doing business in that centre of the world's shipping the Royal Exchange, London, or by one of the several insurance companies that specialise in such policies, with the names of which we are all very familiar through their public advertisements.

Some merchants execute all their business through underwriters ; and others through companies. And it is no part of the scope of these chapters to advise one or the other. It may be explained, however, that in the case of Lloyd's the risks are generally shared between several underwriters ; each of whom signs or " underwrites " the policy. In the case of insurance companies, however, they naturally issue their own formal policies.

Insurance Policies

In a recent article we detailed the course to be taken in effecting a policy ; but there are so many kinds of policies in use that the most important of them must be specified.

For instance, in a " time " policy the duration of the risk is particularly specified. A " voyage " policy is for the length of the voyage. When goods are shipped to a foreign port in a ship the name of which is not known a " floating " policy is often effected.

We will assume, however, that you are dispatching some goods from London to Australia, and in the interest of your customer you are going to insure them from port to port. You may insure them free from " General Average," free from " Particular Average " and " Free of all Average " ; and the word average as applied to shipping insurance may be taken to signify " loss."

The point about General Average is that there are so many firms or individuals interested in the cargo of a particular ship. If one of the parties makes a loss, therefore, he becomes entitled to a contribution from all the others interested. These matters are arranged under the rules of an historic conference ; and in charter parties it is usual for these rules to be specifically mentioned. General Average, in fact, applies more to the chartering of a vessel than to the dispatching of a small quantity of goods.

Losses at Sea

Particular Average applies solely to the actual goods that are lost or damaged and the loss is carried entirely by the individual owner, his underwriters or insurance company, and the other owners interested in the ship and cargo have no concern with his loss as they would do with General Average. Under a " F.P.A." policy, however (Free from Particular Average), the underwriters are liable where the ship is stranded, burned, sunk or in collision, in which case the Particular Average is adhered to.

" Free of all Average " means that the underwriters or insurance companies will pay out for total loss only, and in such an instance neither General nor Particular Average will be considered.

The shipping clerk who has to do with the insuring of cargo and goods for export should make himself acquainted with the many risks and perils of the sea, and should when applying for a policy know precisely upon what basis he is insuring. Naturally, the greater the risk accepted by the insurance company or underwriters the larger the premium to be paid, and in deciding in what class to insure goods much must necessarily

depend upon the class of goods. Rates of insurance naturally vary slightly from time to time, but a clerk in possession of the foregoing facts will be able to comprehend the general routine of the insurance of cargoes and to arrange the matter on thoroughly business lines. It should be explained, however, that these remarks apply entirely to the insurance of goods that are being dispatched by ship. The insurance of ships themselves is an entirely different matter and falls under the category of Marine Insurance. One final remark may be made as to the insurance of cargo, and that is that the amount to be insured is usually from 10 per cent. to 15 per cent. *above* the actual value of the goods themselves to allow a margin for profit, trade loss and similar contingencies.

Export Trade

As to the various methods employed in opening up an export business much will naturally depend upon the nature of the goods to be supplied. It must be remembered however, that all over the world there are British Consuls and Vice-Consuls who may be likened to business ambassadors and who keep their fingers upon the pulse of trade in the country in which they are quartered. From time to time these Consuls and Vice-Consuls make reports of their work and of the tendency of commerce in their immediate district, and these reports are easily obtainable through booksellers dealing in official Government publications. In most cases it would be quite in order for a merchant at home to write to a British Consul abroad, putting to him questions of a general nature, but any inquiries of a kind to apply to individuals are better if made through a banker.

There are many firms who send away representatives on long journeys across the world to open up business, and these super-commercial travellers are becoming more in evidence. Naturally, such men are selected for their adaptability and keenness, and in the vast majority of cases they will have served a very long apprenticeship to the requirements of their particular trade.

And in connection with the opening up of export trade the various *Chambers of Commerce* play quite a leading part. These institutions flourish in the large towns and cities of the world and are formed by the leading merchants, to whom membership is generally restricted. Their object is entirely to help and assist in the development of local trade, on the theory that to benefit one particular trade is to help all, and some of these chambers are immensely powerful in funds and influence.

Chambers of Commerce are to a great extent in touch with one another the world over, and for the benefit of their members collate and distribute a great deal of intelligence that affects the shipping and export trade. In this country, though the Chambers of Commerce are purely voluntary on the part of the merchants, they are recognised in a practical sense by the Government, and in some places abroad, notably in France, the Chambers are conducted very much on the lines of an official department of the administration.

Many of the Chambers issue periodically a handbook detailing the work and energies of the particular commercial centre they represent. These handbooks are scattered far and wide over the world, and from the point of view of exporters form excellent media in which to insert advertisements.

In the majority of trades, too, there are issued periodical publications, and handbooks, year-books and other trade journals that circulate over a wide field, according to the nature of the particular trade, and these present a useful advertising opening.

Official Assistance

For the knowledge and assistance of the export shipper and also to form a perpetual thermometer of the outward trade of the country, statistics are prepared with the utmost thoroughness by the Board of Trade with the assistance of the Board of Customs and Excise, and every exporter should study these statistics most closely so that he may appreciate the position and tendency of the particular trade in which he is interested. The most complete details are given in the "Statistical Abstract of the United Kingdom," which is published once a year by the Government Stationers and Printers at a nominal charge, but the majority of almanacks and also the trade journals give an important selection of the figures.

The whole point is that not only the shipper himself but his clerks as well should leave no stone unturned to be thoroughly in touch with their trade the world over, and in a great many cases exporters keep themselves posted with the newspapers of the countries and colonies with which they do business, often taking advertising space in these publications to assist their output. It may be mentioned that all the large advertising contractors at home are able to place advertisements abroad. A. B.

CHOOSING A CAREER.—XIX

The Home Police Forces.—POLICE service offers to a young man of good health and physique the opportunity for a certain career; rapid promotion when deserved; and a liberal pension on retirement, which may take place at an early age compared with other callings or professions.

Thus, it is quite within the bounds of possibility for a man under fifty years of age to have served the required length of time in the police, and then to retire with a weekly income for the rest of his life ranging from £3 to £9, according to his particular rank on retiring.

Quite the largest and most important service in this country is that known as the **Metropolitan Police Force.** The policing of the area of London outside the City limits gives employment to no fewer than 21,000 officers; whilst it is worthy of note that there are approximately three thousand individual appointments above the rank of constable; and that every official in the service (other than certain clerks selected by the Civil Service Commission) must have commenced as an ordinary policeman and have worked his way up through the various grades by sheer ability and merit.

Among the qualifications necessary to become a constable in the Metropolitan Force are the following: To be over 20 and under 27 years of age. To stand a *clear* 5 feet 9 inches, without shoes or stockings. To be able to read well, write legibly, and have a fair knowledge of spelling. To be generally intelligent, according to the judgment of the officers by whom he will be examined. To be of a strong constitution, free from any bodily complaint, and, in the opinion of the Chief Surgeon, physically fit for the performance of Police Duty, and, finally, to be a British Subject and of pure British descent.

Any young man of good character and in sound bodily health who possesses these qualifications should, if he wishes to become a constable, apply by letter for an official application form to the *Recruiting Department, Metropolitan Police Office, New Scotland Yard, London, S.W.*1.

As to the salary and prospects, it will be well if we go into them in detail. At the very commencement of his career an accepted candidate is required to undergo a course of training at a Preparatory Class, which includes drill, physical culture, and other subjects which develop the qualities required of a constable.

On joining, a constable receives 70s. per week. By a system of co-operative catering he is able to obtain an ample supply of good food at a low cost. In some circumstances, too, allowances are made for rent. He receives his pay every Wednesday for the week ending the Sunday before; and of course clothing is supplied to him.

Libraries, reading, recreation and billiard rooms are provided at the various stations and equipped with everything necessary at no cost to the men. The pursuit of active athletic amusements of all kinds is encouraged; and there are cricket and football clubs in all Divisions. Bands have been established in many of the Divisions, and men who have any musical abilities can find scope for them.

So far as the rates of pay are concerned in the uniform branch they may be summarised as follows:

Superintendents, £550 to £700 per annum; these officers also receive allowances and are supplied with horses and grooms or motors.

Inspectors, 125s. to 193s. per week.

Sergeants, 100s. to 120s. per week.

Constables, 70s. to 90s. per week; with further increments of 2s. 6d. after 17 and 22 years' service, subject to good conduct and efficiency.

It will be obvious then that from the very first week of joining the Force a young man is enabled to cover his entire cost of living and to save a considerable portion of his pay.

It should also be borne in mind that there are gratuities for special duties; and the considerable number of officers employed in the Government Departments, the Royal Palaces, Dockyards and Military Stations away from London are entitled to small extra pay.

Free medical attendance is provided for the whole Force, and convalescent homes exist for the treatment of men recovering from serious diseases. There is a Provident Fund, established and managed by the men themselves, which provides a system of mutual insurance at a low rate. The Metropolitan and City Police Orphanage provides for the children of men who die in the Service; and in all such cases a grant —varying according to the rank of the officer—is made from the Police Fund to cover funeral expenses.

There is a well-endowed Fund for the relief of any cases of distress arising from illness or domestic trouble in the families of Police Officers; and there is also a Fund

from which grants are made to widows in cases of need over and above any pensions or gratuities to which they may be entitled from the Police Fund.

The officers of the Force up to the rank of superintendent are selected without exception from amongst the men themselves. These appointments are never filled by outside persons or by anyone who has not served first as a constable, and then obtained promotion through the various grades of sergeant, inspector and so on. Merit determines promotion, and men who show themselves deserving and capable are brought to the front.

Pensions for life are granted, to all men qualifying, on a more liberal scale and enjoyable at an earlier age, than can be obtained outside the Police Service. As a contributory measure towards these pensions an officer's pay is subject to a deduction of 2½ per cent.; though at present only 2 per cent. is being deducted.

The maximum pensions of the Metropolitan Police Force are:

Constable	£165 per annum.
Sergeant	£195 ,, ,,
Station Sergeant ..	£208 ,, ,,
Inspector	£252 ,, ,,
Sub-Divl. Inspector..	£281 ,, ,,
Chief Inspector ..	£335 ,, ,,
Superintendent ..	£466 ,, ,,

The greatest advantage of the pension scale is that it secures absolutely an adequate provision for life for any man who may be unfitted for work as the result of injury arising in, or in consequence of, the execution of his duty as a policeman.

From the moment a man becomes a constable he is so protected. There is no limit of time before a pension can be given in such cases. Thus, if it should happen that a constable is injured on duty and incapacitated in the first week of his service he would receive a pension for the rest of his life which would be equal to the full amount of his pay; or such a proportion of it as the nature of the injury and the resulting incapacity might require.

In the event of any officer losing his life as the result of an injury on duty his widow will receive a pension, and allowances will also be made to his children until they are 15 years of age. A pension is granted to widows of all men who die from any cause at any time after the completion of 5 years' service in the Force, or after being pensioned therefrom.

Men of keen intelligence who possess sufficient educational advantages are advanced after a more or less brief period of service in the uniformed ranks to fill vacancies as **Detectives**; and as officers in the **Criminal Investigation Department.** These men are of course employed in plain clothes; and there are splendid opportunities for advancement in this Department for men who display merit.

The Metropolitan Police Force is frequently and justly referred to as the finest body of men in the world; and the openings it offers for a life-time career compare most favourably with those of any other calling for the young man with the advantages of ordinary education.

Strangely enough, though the Metropolitan Police Force is the largest in the country, the **City of London Police** must be one of the smallest, seeing that it numbers only about 1,200 officers. The conditions of recruiting are much the same as those of the larger body; except that there is a very high physical standard set by a minimum height of 5 feet 11 inches, with a chest measurement of 38 inches. The age limits for applicants are from 20 to 27 years.

Candidates for admission to the ranks of the City of London Police Force should apply in writing for forms and full details to the *Chief Commissioner, the City Police, Old Jewry, London, E.C.*, marking their envelopes in the top left-hand corner "Applicants' Department."

The **Thames Police Force** is recruited from men who have served some part of their lives at sea and who are trained boatmen.

Quite an important part of London life are these policemen afloat. They are to be seen in their blue uniforms patrolling up and down the Thames in motor launches and other craft, keen and vigilant. Their duties are chiefly the regulation of river traffic, and the preserving of public discipline among the sailormen who use our great waterway; though all sorts of tasks come to them, including the recovery of the drowned and drowning from the stream.

It must be remembered, too, that property of enormous value is borne upon the bosom of the Thames, some of it lying in strings of lighters, and all this costly merchandise calls for special guarding.

Naturally applicants for positions in this Force should be good swimmers and, in the first instance, would-be candidates should apply to the *Metropolitan Police Office, New Scotland Yard, London, S.W.*1. A. C. M.

BOOK-KEEPING.—XIII

THERE are two points of view from which every consignment may be considered, namely, that of the consignor, and that of the consignee. Every consignment is, from the consignor's point of view, a consignment outwards, whilst in the books of the consignee the same consignment will be treated as a consignment inwards.

Consignments (Inwards)

In the last lesson the student was shown how to record in the books of the consignor particulars of consignments outwards. In this lesson we propose to explain how the accounts are kept in the books of the consignee, that is, of consignments inwards.

It will be remembered that the goods are not purchased but are received for sale on account of the principal, the consignee being his agent for the time being.

In the books of account there are two ways of dealing with consignments inwards, but the method recommended below is, without doubt, the clearer and more logical way of recording the facts. As the goods are not purchased, but are to be kept until sold, no entry is to be made in the Purchase Book.

Let it be supposed that Mr. Bertram Phillips, of New Zealand, has sent to you a consignment of goods. They are valued at £360, but you are expected to sell them for the highest price obtainable.

When the goods arrive you will make no entry in your books of account, because the goods are not yours, and you have given no undertaking to pay for them.

When the goods are delivered, you will probably be asked to pay various charges, such as dock dues, landing charges, cartage, etc.

We will assume that the amounts thus paid are £9 10s. 0d. for dock dues and general charges, and £10 for fire insurance. It is clear that these charges are paid on behalf of your principal's goods, and it will be necessary for him to be debited with the amount.

The transaction will be passed through the Cash Book where the entry will appear as follows :—

CASH BOOK

		Cash.		
		£	s.	d.
By B. Phillips (charges and insurance)		19	10	–

As Mr. Phillips is not able to command unlimited capital, he may ask you to favour him with an advance against the consignment. You agree to his suggestion and forward to him a cheque for £150. This will be entered in the Cash Book thus :—

CASH BOOK

		Bank.		
		£	s.	d.
By B. Phillips		150	–	–

In the course of time you sell a portion of the consignment to Miles Townley for £300, and the balance to Felix Stone for £200. This is in effect a sale by your principal, Mr. Bertram Phillips, to the two persons named, and the transactions shown in the form of a Journal entry will be recorded in your books as follows :—

		£	s.	d.	£	s.	d.
Miles Townley	Dr.	300	–	–			
Felix Stone	Dr.	200	–	–			
To Bertram Phillips					500	–	–

Having disposed of the goods you will take the necessary steps to inform Mr. Phillips of the fact.

This intimation of the disposal of the goods will take the form of an Account Sales which may be made out as follows :—

Account Sales of a consignment of goods sold by the undersigned for and on behalf of Mr. Bertram Phillips.

Your charge of £25, which represents 5 per cent. commission on the gross proceeds and which is the remuneration you receive for your services, may be journalised as follows :—

Marks.	*Particulars*	*Description.*	£	*s.*	*d.*	£	*s.*	*d.*
		Gross proceeds of sale of goods				500	–	–
		Less landing charges	9	10	–			
		Less insurance	10	–	–			
		Less commission at 5 per cent. on £500	25	–	–	44	10	–
		Net proceeds				£455	10	–
		Less cheque on account				150	–	–
		Amount due				£305	10	–

E. & O. E.
Name and address of Agent, also date.

		£	*s.*	*d.*	£	*s.*	*d.*
B. Phillips	Dr.	25	–	–			
To commission					25	–	–

In the event of your receiving payment from the two persons to whom the goods have been sold, the amounts will be passed through the Cash Book and credited to their personal accounts, which will then be closed.

From the Account Sales shown above it is evident that the amount due from you to Bertram Phillips for the goods sold on his behalf, is the net proceeds, that is, £455 10s. less the amount remitted to him on account by cheque, that is, £150, and you will now forward to him the balance of £305 10s., recording the fact in the Cash Book.

The Ledger accounts recording the complete transaction will then appear in your books as shown at the bottom of this page and at the top of the next.

The reading of these Ledger accounts should present no difficulty to the student. He will note that although the goods are apparently sold at a profit, that profit does not belong to the consignee but to the principal on whose behalf he is acting. The agent's services are recompensed by the commission of 5 per cent. placed to the credit of the Commission account, and afterwards transferred to the credit of the Profit and Loss account.

The alternative method of dealing with consignments inwards and which does not represent so accurately the position of affairs is as follows :—

On receipt of the goods a consignment inwards account is opened, and this is debited with the invoiced value of the goods and with

B. PHILLIPS

	£	*s.*	*d.*		£	*s.*	*d.*
To Cash (charges)	19	10	–	By M. Townley	300	–	–
„ Cash (advance)	150	–	–	„ F. Stone	200	–	–
„ Commission	25	–	–				
„ Cash	305	10	–				
	500	–	–		500	–	–

MILES TOWNLEY

	£	*s.*	*d.*		£	*s.*	*d.*
To B. Phillips	300	–	–	By Cash	300	–	–

FELIX STONE

	£	s.	d.		£	s.	d.
To B. Phillips	200	–	–	By Cash	200	–	–

COMMISSION ACCOUNT

	£	s.	d.		£	s.	d.
				By B. Phillips	25	–	–

all costs and charges. The same account is then credited with the proceeds of the sale of the goods. The difference represents profit or loss on the consignment. The personal account of the consignor is credited with the invoice value of the goods and debited with all payments made. The difference between the two sides of the personal account will be the same as the profit or loss shown in the consignment inwards account. The following illustration will make this clear.

CONSIGNMENT INWARDS ACCOUNT

	£	s.	d.		£	s.	d.
To B. Phillips	360	–	–	By M. Townley	300	–	–
„ Cash (charges)	19	10	–	„ F. Stone	200	–	–
„ Commission	25	–	–				
„ Balance (profit) transferred to B. Phillip's account	95	10	–				
	£500	–	–		£500	–	–

B. PHILLIPS

	£	s.	d.		£	s.	d.
To Cash (advance)	150	–	–	By Consignment Inwards	360	–	–
„ Cash	305	10	–	„ Balance (profit)	95	10	–
	£455	10	–		£455	10	–

When goods are consigned to an agent and he agrees to pay for them if the person to whom he sells the goods fails to do so, he is said to be a del credere agent, and in consideration for his making this very valuable guarantee he receives an extra commission, which is known as del credere commission.

In the method recommended above for treating consignments inwards no entry will be made for the goods remaining unsold when the goods are sold. The goods on consignment are not yours and must not be taken into account until sold. If, however, you have paid any advance or charges against them, the sum paid will be treated as an asset in your balance sheet, as it is an amount which you can claim at least as security.

Definitions of terms

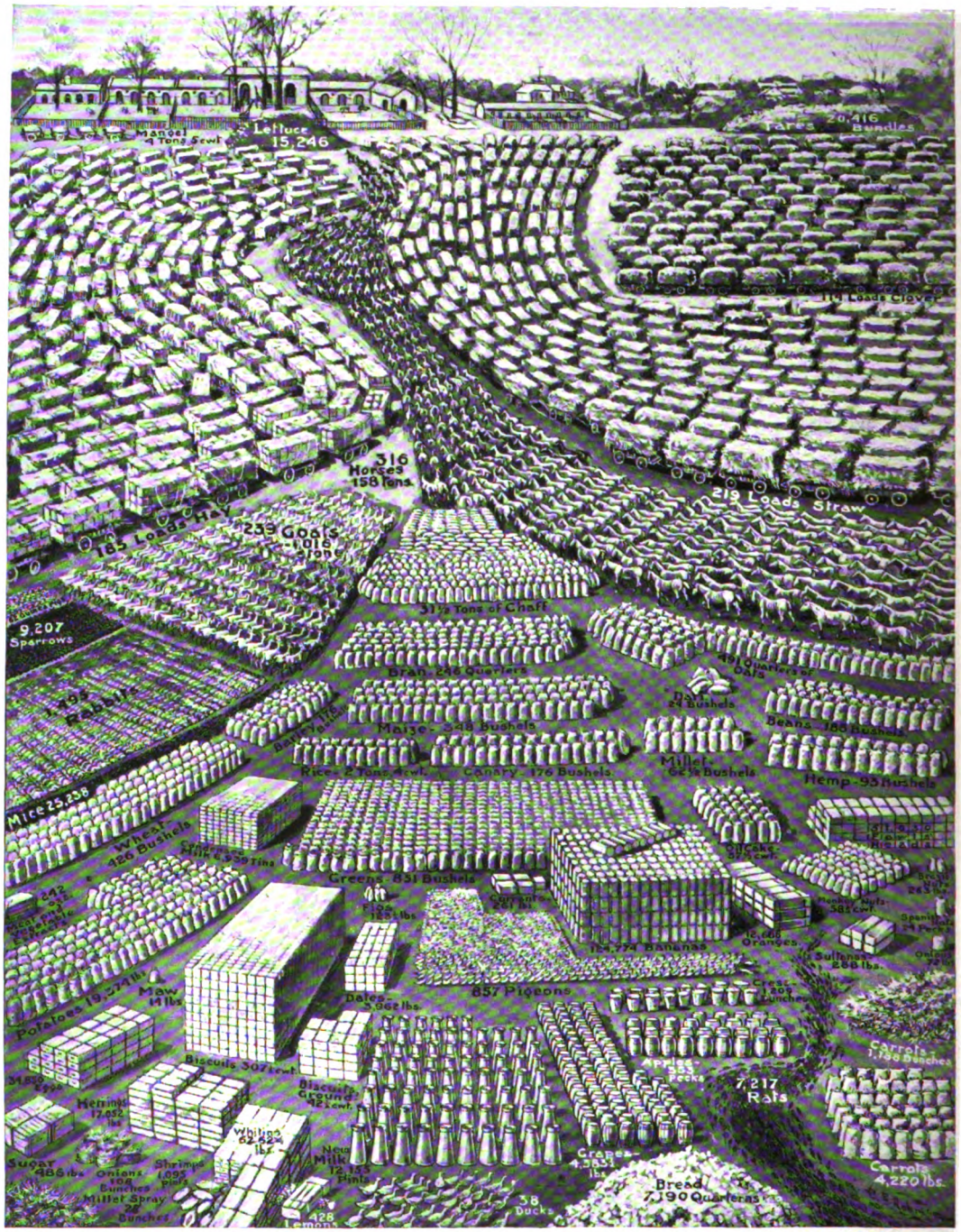
Duties are taxes imposed by the Government on various goods, and are of two kinds.

(1) **Excise Duties**—those placed on goods produced and consumed at home, or

(2) **Customs Duties**—those imposed on goods exported from, or imported to, the country.

Among the latter class of taxable goods are such well-known commodities as tea, and tobacco.

F. H.



Drawn by W. B. Robinson.

FEEDING THE ZOO.

The above chart gives a general idea of the nature and quantity of food demanded annually by the beasts in the London Zoo, whose appetites, however, like those of their human neighbours, were sternly curbed by the Food Controller during the period of the War. Many of the commodities shown above were then excluded from the Zoo.

Continued from page 129.

ENGLISH LANGUAGE AND LITERATURE:

***Contributors*:**—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

THE AGE OF POPE

ALEXANDER POPE reigned over English literature for thirty years an unquestioned monarch. His sway was more complete than that of Dryden, or of Ben Jonson, each in his day. But controversy as to his place as a poet has persisted ever since. There are critics who now deny that Pope was a poet at all. They say he entirely lacked inspiration, but was supreme in artifice; that he cleverly turned prose-thought into perfect mechanical rhyme; that he mirrored accurately an artificial age, but never spoke straight to the human heart; that he was a writer of maxims, with but little lyrical power, and that when he tried to write finely he never soared above rhetoric.

Youth and Education

This tone of criticism is partly a result of acute dislike of the man. Pope combined fine mental acuteness and brilliant wit with an utter want of veracity, and with incredible meanness. No trick was too contemptible for his use, if it would feed momentarily his inordinate longing for fame. His life's aim was to present himself to the world as a prodigy, often at the expense of his friends. For this he plotted, deceived, and even forged; and he has been found out.

But though so mean and petty in many ways Pope occupies a prominent place on the literary stage, and a just understanding of him, and allowance for him, is a fine exercise in toleration.

He tried hard, but in vain, to suggest that he was akin to a noble family, but really he was the son of a respectable Roman Catholic linen draper, of London, where he was born in 1688. One of the best features of Pope's character was his lifelong quiet adherence to the faith of his father, after it had been a great handicap in his youth. As a Catholic, Pope could not be educated at a University. His education, indeed, was private and desultory, and he was never a sound classical scholar. From boyhood, however, he browsed among books, preferably the works of the poets, and by the time he was in his teens was an assiduous practiser of verse on the models of Dryden. His father had retired from business with a modest independence, and the son lived with him near Windsor.

Here, again, tribute must be paid to Pope for his filial affection. He was an excellent son, both to his father and to his mother, and the tenderest lines he ever wrote tell of his care for his mother in extreme age.

Me, let the tender office long engage
To rock the cradle of reposing Age,
With lenient arts extend a mother's breath,
Make languor smile, and smooth the bed of Death,
Explore the thought, explain the asking eye,
And keep a while one parent from the sky!

Physical Infirmities

Partly, it is said, through devotion to study in his boyhood, Pope became stunted and deformed, and passed much of his life in physical misery. From the beginning everything was against him—inadequate education, the sense of being banned, solitude, bodily infirmity—and he was thrown back on himself. But as a boy he was brilliantly unusual. His *Pastorals*, published in a *Miscellany*, when he was twenty-one, were said to have been written when he was sixteen. Of this, however, we cannot be sure; for his vanity often made him falsify the dates.

But there is no reason for doubting that he was taken to Will's Coffee House to see Dryden, which must have happened before

he was twelve years old—a proof of the bent of his interest.

In his teens he was proud to make the acquaintance of William Wycherley, one of the debasers of the Restoration Drama, then with a fading reputation. The boy and old man corresponded freely. The correspondence was published late in Pope's life, but, as was his custom with correspondence, it was so "doctored" as to be misleading.

Indeed all of Pope's correspondence, before publication, was revised by him after he had recalled his own letters from his friends. These he not only re-wrote, but he also re-wrote his friends' letters to him, all with a view of showing himself in a favourable light. He did this with Swift's letters, after Swift was no longer able to guard his own reputation.

Critic, Satirist, and Philosopher

In 1711 his *Essay on Criticism*, a cleverly rhymed summary of the canons of criticism laid down by classical writers, placed the poet at once in the first rank of living authors. Next year his *Messiah*, published in the *Spectator*, and his *Rape of the Lock*, a brightly written satire on the feminine foibles then fashionable, enhanced his reputation. *Windsor Forest*, published in 1713, had been written much earlier.

Pope now set himself the task of translating *Homer*—a task which occupied him, and inferior writers whom he employed cheaply, and superintended, until the year 1725. From this work he cleared eight thousand pounds, and afterwards lived in comfortable independence.

The *Homer* was immediately popular, and probably continues to be the translation most frequently read. Everyone who reads Greek admits it is not Homer; and, equally, everyone admits that it gives an interesting account of the happenings in Homer. Homer is simple, bold, natural, primitive. Pope artificial, abstract, formal, modern. But he is pre-eminently readable. His understudies—Broome and Fenton by name—imitated his manner so closely, after practice, that no one can tell by the style which parts he wrote and which they wrote. They were much better scholars than he, and did not have to translate from a French translation.

Pope has the honourable distinction of being the first poet, who, apart from the drama, lived by his pen, and needed neither private patronage nor public office.

After the publication of his translations of Homer the poet could choose his subjects without any thought of popularity. What he chose to do was to write, and re-write, his *Dunciad*, lashing with a cruel whip the lesser writers of his day; to compose *Moral Essays and Epistles*—the chief being his *Essay on Man*, an ill-digested resumé of philosophy which he had heard his friend Bolingbroke talk; and to imitate Horace's satires.

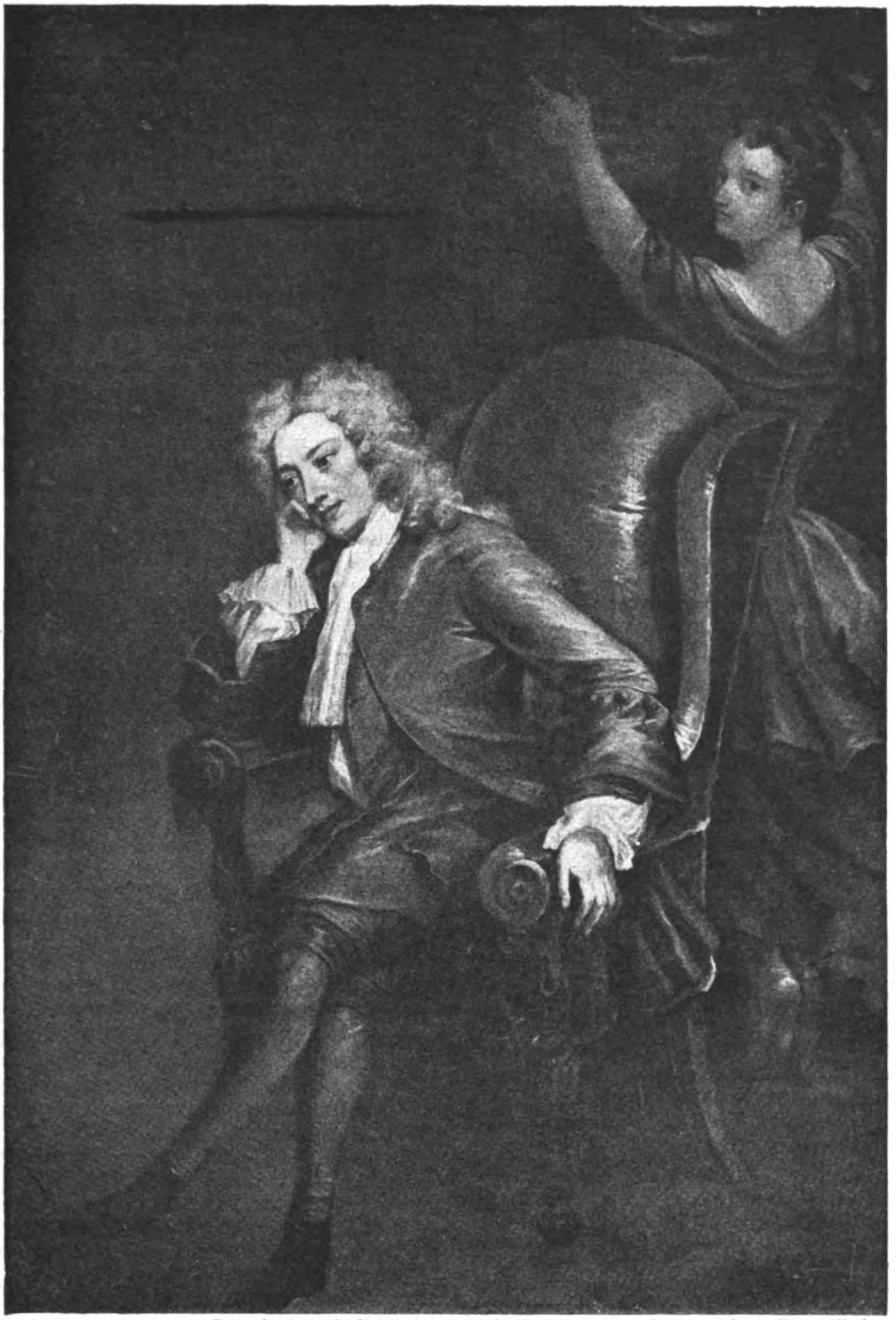
The workmanship of these poems is extremely clever. Pope, indeed, brought the couplet to absolute perfection. In no other writer are ease and compression blended with such a masterly touch. To an age that revelled in "morals" he presented them packed in the neatest and most accessible forms. It is true he had no system of thought, and wrote to no determined end. When the general tendency towards atheism of the thoughts he had "conveyed" from Bolingbroke was pointed out to him, no one was more amazed than he.

He tried to be a critic, a satirist, and a philosopher. As a critic he was skilful and thoroughly sensible. He understood particularly the forms of verse most admired by his age, for he had given them their last perfecting touches. As a satirist he was keen, caustic, and deft—a terrible enemy! As a philosopher he could not write a score of lines without getting beyond his depth; but he had the knack of constantly saying something, that, by its aptness, would withdraw attention from his inability to sustain a longer flight of thought.

Was Pope a Poet?

Was he then a poet? We must unhesitatingly reply in the affirmative, if we are to give the breadth to poetry which it has always had from antiquity. Satire may be a poorish form of poetry, but it is a form. The everlasting jog trot of the rhymed couplet may become intolerably wearisome, but it has its uses. As for the feeling in verse, we must not demand that it shall only be of gossamer delicacy, or ethereal exaltation, or thrill with human passion, or respond to the sweet undertones of Nature, or stir us to heroic sacrifice; in these and a multitude of other ways poetry finely moves us to fine issues, but it also has its lowlier levels of good sense, and smartness, and bright wit, and on these lower levels Pope is a master.

At times, too, rarely, but often enough to prove his higher quality when in his more exalted moods, he becomes a poet who can touch the heart as well as stimulate the mind, as an extract from his *Elegy on an Unfortunate Lady* will show:—



From the picture by Charles Jervas, in the National Portrait Gallery. Photo: Emery Walker.

ALEXANDER POPE WITH MARTHA BLOUNT,

the faithful friend to whom he left the bulk of his property. Pope died in 1744 at Twickenham, and there he is buried.

By foreign hands thy dying eyes were closed,
By foreign hands thy decent limbs composed.
By foreign hands thy humble grave adorned,
By strangers honoured and by strangers mourned!
What though no friends in sable weeds appear,
Grieve for an hour, perhaps then mourn a year,
And bear about the mockery of woe
To midnight dances, and the public show . . .
Yet shall thy grave with rising flowers be drest,
And the green turf lie lightly on thy breast.
There shall the morn her earliest tears bestow,
There the first roses of the year shall blow
While Angels with their silver wings o'ershade
The ground, now sacred by thy relics made.

But as a rule it is Pope's literary workmanship that interests us more than his thought. He was like a merchant who makes a name for his goods by attractive packing. Neatness was his foible. So much in love was he with "the style that evenly proceeds" that, in amusing self-complacency, he compares it favourably with Milton's verse—a gloriously-varied music for which he had no ear.

Martha Blount

As an example of his attention to literary technique we may quote from his *Essay on Criticism* his criticism of certain faults in verse, and his plea for wedding sound with sense, points that are illustrated in the very lines which state the case. Of certain writers he says—

These, equal syllables alone require,
Though oft the ear the open vowels tire;
While expletives their feeble aid do join;
And ten low words oft creep in one dull line.

Here the equal syllables, the open vowels, the expletive "do," and the ten low words are all brought in as examples of the weaknesses to be avoided.

Again notice—and to notice properly one must read aloud—the lines that follow, picturing the whisper of the breeze, the flow of quiet waters, the rugged abrupt strength of the lines betokening effort, and, lastly, the light swift undulating movement as of the wind sweeping over the wheat.

'Tis not enough, no harshness gives offence,
The sound must seem an echo of the sense.
Soft is the strain when Zephyr gently blows,
And the smooth stream in smoother slumbers flows;
But when loud surges lash the standing shore,
The hoarse rough verse should like the torrent roar;
When Ajax strives some rock's vast weight to throw,
The line too labours, and the words move slow;
Not so when swift Camilla scours the plain,
Flies o'er the unbending corn and skims along the main.

In 1744 Pope died where he had long lived, at Twickenham, and there he is buried. Many of his friends had died before him or become estranged, but a kind maiden neighbour, Martha Blount, remained faithful, and to her he left the bulk of his property. The pity of his life is that the anxious efforts he made, at any cost, to secure fame, have blurred his reputation far more than the enemies whom he aroused and scourged. He was at once the cleverest and the pettiest of the poets who just fall short of literary greatness.

George Berkeley, the philosopher of the age, and one of its most honourable and charming men, was born in Kilkenny, in 1685, and educated at the school there, like Congreve and Swift. By the time he was five-and-twenty he had published his *Theory of Vision*, and his *Principles of Human Knowledge*. The theory he expounded was that things which men call real have no existence, except as they are perceived by the understanding. It is our own ideas that we perceive, and the ideas are really the things. Only spirit exists. This theory he went on defending through life. Berkeley was well known in London literary society after the publication of his books in 1709 and 1710, and was exceedingly popular. Even Pope said he was possessed of every virtue.

Prior and Gay

After he had spent his fortune in trying to establish a missionary movement in the Bermudas he was made Bishop of Cloyne. He died in 1753.

Matthew Prior (1664–1721) was a merry diplomatist, born at Wimborne, who spent much time abroad, and made poetry "the amusement of his life," as he said. But, late in his career, a collected edition of his poems sold so well that he was lifted from poverty to affluence. Though Prior sometimes used the heroic couplet of Dryden and Pope, he more frequently used the freer measures of an earlier age, and has preserved his memory through bright snatches of song.

John Gay (1685–1732), was a light-hearted member of the circle which included Swift, Pope, and Prior. His readable *Fables* are still known by the young. He wrote, too, some rollicking ballads, and founded comic opera with his popular *Beggar's Opera*. Like Prior, he was buried in Westminster Abbey.

After the Elizabethans, and the later writers, like Herrick, who echoed the Elizabethans, poetry had been taken to town. Dryden and Pope and all their school were city men. Pope's *Windsor Forest* is as near to Nature as a scene on a stage curtain, and

no nearer. But the poetry of the country, and of common life, was not quite killed by the poetry of town wit. It was when Pope was at the very height of his power (1727) that John Dyer, a Welshman, educated at Westminster, was singing of the peace to be found in the groves of *Grongar Hill*—

Be full, yet courts, be great who will;
Search for Peace with all your skill;
Open wide the lofty door,
Seek her on the marble floor;

From the portrait by William Aikman in the Scottish National Portrait Gallery.

JAMES THOMSON (1700–1748), whose *Seasons* made itself felt throughout the literatures of Europe.

In vain you search, she is not there;
In vain ye search the domes of care;
Grass and flowers Quiet treads,
On the meads, and mountain-heads,
Along with Pleasure, close allied,
Ever by each other's side;
And often, by the murmuring rill,
Hears the thrush, while all is still,
Within the groves of Grongar Hill.

The note of the country was coming back, soon to make common the hollow tink-tank of mechanical town-born verse.

At the same time Allan Ramsay (1686–1758), a Scottish wigmaker turned bookseller, was publishing old and new Scottish vernacular songs, that, later, had an inspiring influence on Robert Burns, and was also writing his *Gentle Shepherd*, which brought pastoral verse nearer to the sheepfold than it had ever been before, though it was still idealised too finely.

Further, between 1726 and 1730, a young Scotsman, James Thomson, born in 1700, and educated for the ministry, had made his way to London, and was publishing his *Seasons*.

This poem was destined to make its influence felt throughout the literatures of Europe, and appeal afresh to that love of the outdoor world which can never be weakened by literary fashions.

Thomson rejected boldly the measure by which the classical school had striven to confine serious verse, and went back to the blank verse of Milton. Later (1748), in his pleasing *Castle of Indolence*, he successfully adopted the Spenserian stanza.

Thomson's poetry of nature in *The Seasons*, a poem often revised and expanded, is hampered by the thought of his age, clogged with discursions and moralising, and

From the portrait by Sir G. Kneller in the National Portrait Gallery. Photo: Emery Walker.

JOHN GAY (1685–1732). A light-hearted member of the circle which included Pope, Swift and Prior.

sometimes the scenes are painted on too broad a canvas, but there is never any doubt about the enjoyment with which the poet watched the transformations of the open-air world.

Not only did Thomson give Nature back to literature, but he deeply influenced poets, unborn in his day, who would see her with an even clearer vision and a more understanding sympathy. He was one of the permanent forces in our literature. J. D.

THE ENGLISH LANGUAGE.—XI

THE aim of a description is to present to the reader an account of objects or phenomena exactly as they were perceived by the writer. In carrying out this aim the writer may be content with a simple enumeration of the facts as they were seen by himself or as they might have been seen by another person in the same situation; or on the other hand he might attempt to reproduce the impression that the facts made upon him. These two methods give us what may be called scientific and artistic descriptions respectively. More frequently we have a combination of the two, in which what is seen is described so that the facts appear after refraction through the writer's personality. They are not necessarily the less accurate for that; but they will be enriched with colour and suggestions which are not of necessity inherent in the object described.

Of the first kind of description little more need be said; its purpose being merely to convey information, the style should be concise and simple, the arrangement orderly and methodical. We should adopt it in advertisements, catalogues, inventories and in descriptions of scientific processes and phenomena, or of buildings and the like, in which no artistic effect is desired.

Descriptive Writing

The artistic description is a very different thing, and like the personal narrative calls for all that is best in the writer's literary powers. Probably the most important point to remember in connection with such a description is that which has to be present to the mind of an artist when he is painting a picture. Whatever the subject may be, it is impossible to include every detail of it, and the effect depends upon a suitable selection among these details and a proper harmony in the treatment of those which are selected.

In the description of a landscape, for example, certain details contribute more to the general effect than others, and it is upon these that the writer, like the painter, must fix his chief attention: to them he must devote his special care. The objects in the background are not necessarily to be ignored, but they will not receive the same minute treatment as those which are prominent in the foreground. This proper subordination of the unimportant detail to the salient and expressive is a decisive factor in successful description. In the description of a person it is as important as in landscapes. A portrait is not the same thing as a photograph, apart from the question of colour. Certain features of the person described—it may be the eyes, or the mouth, or some detail of dress or of movement—are more characteristic of the subject than others; and the true artist will, without exaggerating or running into caricature by over-emphasis, give exceptional attention to these.

Next to the choice of details, it is important for the writer to be clear about his point of view. He will write differently if he is a mere outsider or spectator than if he is a participator in the events described. It is usually necessary for the point of view to be indicated, either directly or indirectly. If the point of view changes during the course of the description, it is important that the change should be made clear.

Narrative Style

The order in which the details are to be developed depends upon the circumstances. We may proceed from the general to the particular, beginning with a statement of the broad impression that we desire to make, and proceeding to fill in the general statement thus made with details which enhance it. Or we might follow the opposite course, and by an accumulation of minor details lead up gradually to the larger matters, and thus make our whole complete. Or we might describe the individual points as they come to our senses, in the order in which they make their effect on our minds. In either case, we must avoid confusion by a consistent method and by careful attention to proportion. Further still, we must take care that our details are properly grouped about some central focus of main interest, or in due balance and relation to the whole.

A description is usually a portion of some larger composition, acting as the setting of a narrative or providing the environment of a story. When this is the case, the writer is still further restricted by the necessity of harmonising his description with the more important narrative features. Sometimes description and narrative blend into one another completely. Interwoven with the narrative of incidents we find little descriptive touches which bring things and persons vividly into the mind. This compound form of composition is, of course, common in fiction, and is very serviceable whenever incidents are narrated which involve activity or movement.

The language in a description is impor-

tant; words should be chosen for the fullness of their effect rather than for precision. Metaphors and other figures are not out of place; but chief attention should be paid to the expressive, picturesque and vivid words which bring the whole object into the mind's eye. Consider any description that has impressed you from this point of view, and try the effect of changing any of the descriptive words for others that may occur to you as possibly suitable.

In choosing a subject for description, a writer should always bear in mind that he can never do better than reproduce the effect which the subject has made upon his own mind. Description is essentially a personal matter. Hence it is useless to expect good results from subjects which do not interest us. Our own mental standpoint will always be interfused with any descriptive writing that we do; the attitude of the sculptor is different from that of the painter, for example, though both may be artistic; and it is the same with writers: each must choose that subject, or that aspect of a subject, which has impressed his own vision.

Exposition

Exposition is akin to description, but does not of necessity deal with sensible objects. In its simpler forms we see it as the exact definition of a word or thing; when the definition or explanation is extended so as to expound fully the object or matter concerned, a more elaborate treatment becomes necessary. The description of an instrument or of a process is comparatively straightforward; the facts, and to some extent the order of their development, are present before us, and fixed by the nature of the case; but in the exposition of a principle or of an abstract theme, both the matter and its arrangement depend upon the writer's knowledge and judgment.

Such a full exposition should be introduced by a statement in general terms of the principle to be expounded, including in a pleasant and indirect form, some statement of the scope and meaning of the subject. The general statement should then be illustrated or amplified by a series of examples or points which develop it in detail, arranged in a natural and intelligible sequence, and leading up to an effective conclusion in which the general point of view of the composition is emphatically stated and the introductory remarks endorsed. Only those points should be introduced which bear directly upon the matter to be expounded, and the language should be lucid and unambiguous.

Exposition passes naturally into argument whenever it deals with subjects on which two opinions are possible, as is the case with most principles. The persuasive power of an argument depends at the end upon the logical force with which it is presented, though this is aided, often more than it should be, by other devices such as the use of emphatic or highly-coloured rhetoric, by careful suppression of facts which tell against the writer or by a deliberate attempt to overwhelm the reader's emotions at the expense of his understanding.

Rhetorical Tricks

These tricks of the professional pleader are fatal to the success of any written argument. For this we need a strict sincerity, a careful and consistent use of terms, and a straightforward dealing with the adverse point of view.

Mere assertion is no substitute for reasoning, and the noisy emphasis of any statement is an evidence of weakness rather than strength. Put the opposite standpoint clearly and fairly, and deal with it calmly. In particular we again mention the necessity of defining all words that may be taken ambiguously. It is not at all uncommon to hear violent arguments in which the disputants, when challenged, are found to attach quite different meanings to the leading terms in the dispute. Such words as Theology, Art, Liberalism, Socialism, and the like—in their nature of large and general import—are often employed in narrow and restricted senses by advocates whether *pro* or *con*.

Exercises

1. From any novel of Scott's or Dickens', find passages of (*a*) pure description, (*b*) descriptive narrative, and contrast these two novelists from each point of view.

2. Describe *one* of the following:—(*a*) a crowd on election day; (*b*) the company in a drawing-room; (*c*) Sunset among Mountains; (*d*) Early morning at Sea; (*e*) A Naval Fight; (*f*) The Storming of a Trench; (*g*) The Death of a Hero.

3. Develop an argument showing the reasonableness of your own point of view on *one* of the following subjects:—Woman's Suffrage; National Service; Compulsory Secondary Education; Tariff Reform; Local Option; Religion without Churches.

4. Discuss the following dicta:—(*a*) If you wish for peace, prepare for war; (*b*) France has contributed more to the general culture of the world than Germany; (*c*) A benevolent despotism is the best form of government; (*d*) Science has raised more problems for the human race than it has solved; (*e*) Poetry is the most valuable product of the human mind.

E. W. E.

From the picture by C. A. Schwerdgourth.

MARTIN LUTHER BEFORE THE EMPEROR CHARLES V.

at the Diet of Worms in 1521. The deliberations of the Diet resulted in the reformer being declared a heretic and formally outlawed.

Continued from page 138

HISTORY:

Contributors:—**J. A. Brendon, B.A.(Oxon.), F.R.Hist.S.; F. Collinson, F.R.Hist.S.; T. P. Evans, B.A.(Oxon.); James A. Manson; L. Stampa, M.A.(Oxon.); and J. B. Sterndale-Bennett.**

THE REFORMATION IN GERMANY

WHILE the happenings recorded on pages 131 to 138 were in progress—while kings and priests were intriguing and fighting in Italy; while Germany, France, Spain, and the Papacy were alternately using and betraying one another in their own selfish interests—an event of more lasting importance was slowly maturing elsewhere. When Charles V. ascended the Imperial throne, Martin Luther already had raised his voice against the tyranny of Rome, and thereby had begun a movement destined permanently to affect the faith, habits, and character of several nations.

Papal Corruption

The tedious struggles carried on in Italy during the fifteenth century undoubtedly hastened forward the growth of the movement. As a result of these wars, the hold of the Papacy on the minds of intelligent men—in the north of Europe, at any rate—perceptibly weakened. The Papacy had proved itself insincere and corrupt, and people were ceasing to believe in it if only because it had ceased to believe in itself.

When the Popes entered the political arena as sovereign princes, they lost much of that mysterious sanctity which had surrounded their office when they confined themselves to their proper functions, and attended only to matters of faith and morality. As sovereign princes they became the rivals of other princes stronger than they; and men, having once discovered that they were in some respects fallible, began naturally to suspect that this fallibility might extend in other directions.

The desire for temporal power—if only as a something tangible and real by which to enforce spiritual claims—prompted the heads of the Church at quite an early period in history. At first they tried to exercise universal control through the agency of Catholic sovereigns. Gregory IV., for example, in 832, claimed the right to depose kings at will. His successors frequently made the same claim; and, had it been established, the Popes, of course, would have accomplished their purpose, for the kings of Europe would have become merely their viceroys. But this right was never conceded.

The Popes, therefore, were driven to another expedient, and sought to supplement their prerogatives by making themselves independent temporal princes. Thanks, moreover, to the work of Innocent III. (1198-1216) and Nicholas III. (1277-1280) they succeeded, before the close of the thirteenth century, in establishing themselves as absolute rulers of a number of states in the centre of Italy, and became monarchs in every sense of the word.

The Lollard Movement

In the end, they lost by this change more than they gained. None the less—for a while at any rate—the addition of temporal to spiritual power immensely increased the influence and strength of the Popes; and, throughout the Middle Ages, Papal authority proved a constant menace to the independence of Europe. It must be borne in mind, however, that the assumptions of the Popes were never admitted by the whole Christian world. The Greek community repudiated them at the outset; and even in countries which lay within the acknowledged jurisdiction of Rome the spirit of freedom was perpetually breaking forth, the despotism of priests being defied by kings, nobles, and commoners alike.

The Crusading movement, again, although it sprang from the very extreme of fanaticism, gave to the religious exclusiveness of Rome a blow from which it never recovered. The Crusades brought Europeans of all ranks and stations into direct contact with the Moham-

medans; and, as a result of this contact, the men of the East, who at one time were believed to be the very incarnation of evil, came gradually to be regarded as possessing passions, interests, and sympathies by no means dissimilar from those of the men of the West. Many Christian thinkers began, therefore, vaguely to wonder whether the religious sentiment was not capable, after all, of divers manifestations; and, if so, whether it was right that one should claim absolute predominance.

The English reformer, John Wycliffe, who lived during the reign of Richard II., was one of the first openly to challenge the infallibility of Rome in matters of doctrine. The Lollards, as Wycliffe's disciples are known, gave a definite impulse to the reform of the Church; and although the Lollard movement in England was all but suppressed by the severities of Henry IV. and his son, it made marked progress in Bohemia under the resolute leadership of John Huss and Jerome of Prague, both of whom testified to their zeal at the stake.

Sale of Indulgences

The very excesses of these men would have ruined a weaker cause, but religious reform at this time was gaining supporters all over Europe, even in France—a country never inclined to extreme innovations in matters of religion. The disrepute into which the Papacy had fallen is strikingly shown in a decree passed by the Council of Pisa in 1511. This Council, convoked by the Emperor Maximilian and King Louis XII., described Pope Julius II. as a bloodthirsty tyrant, and declared that he had forfeited all claim to temporal and spiritual power. Of course, the decree proved quite ineffectual. Still, that it should have been issued at all, clearly proves how the revival of learning—then spreading everywhere—had strengthened the spirit of inquiry and doubt.

The immediate cause of the great revolt of the sixteenth century was the flagrant manner in which the Popes were abusing the grant of indulgences.

Priests, it must be remembered, were empowered by the Church to forgive sins, if the offender duly confessed and showed himself contrite. But this forgiveness did not free the sinners from the penalties which God—or his representative, the priest—might choose to inflict; nor did it release him from the suffering he would have to submit to in Purgatory—that intermediate state during which, according to the doctrines of the Roman Church, a man, after death, is purified before entering heaven; it merely absolved him from guilt which would have made his ultimate salvation impossible.

Now an indulgence was a pardon, granted by the head of the Church in return for some service required, by means of which sinners escaped the whole, or a part, of this punishment. At the Council of Clermont, for example, in 1095, Urban II. promised plenary indulgences to all who took part in the Crusade then being organised by Peter the Hermit. A similar favour was offered by Boniface VIII. to those who assisted in the celebration of the Jubilee of 1300.

At first, the granting of indulgences was carefully controlled. The custom, however, was manifestly liable to abuse; and the Popes, having found in it an easy, sure way of raising money or troops, later extended it so that a man could secure release from the pains of Purgatory for anyone in whose happiness he might be concerned.

Indulgences, in fact, became articles of barter or sale,. and during the fifteenth century an enormous trade was carried on in them—especially in Switzerland and Germany. These two countries were literally honeycombed with friars, all selling indulgences, and whose motives were purely commercial. Only a percentage of the money they raised ever reached Rome; the friars were careful to deduct for themselves generous commissions.

Martin Luther

Churchmen of all kinds were scandalised by this flagrant abuse, yet they could do nothing to check it, so strong was the hold which the friars had on the masses.

Such was the state of affairs prevailing in Germany when, on November 10, 1483, Martin Luther was born at Eisleben, in Saxony. He was the son of a miner; and the latter, though none too prosperous, contrived to give the boy a good education, first at Magdeburg, then at Eisenach, and finally at the University of Erfurt.

It was the father's wish that Luther should become a lawyer. Luther himself, however, determined to be a monk; and in 1505, despite paternal opposition, entered the Augustine convent at Erfurt. Two years later he was ordained, and such rapid progress did he make with his studies that in 1508 he was appointed Professor of Theology at the University of Wittenberg.

In 1510, Luther went to Rome on some business connected with his Order. This was the turning point in his career, for it was in Rome that his eyes were first opened

to the tremendous corruptions of the Church.

The monks and ecclesiastics whom he had known in his own country, though, perhaps, not very saintly, were—for the most part—at least free from vice. In Rome, however, the capital of the Church, which he had expected to find the source and fount of holiness, Luther beheld a state of affairs which overwhelmed him. The clergy were given to the most extravagant vices, which they practised without any attempt at concealment. Priests scoffed at religion and openly avowed themselves atheists. Scepticism was widely spread among all classes; whilst the leaders, by their laughing disregard of comment, infected all with their own gross excesses.

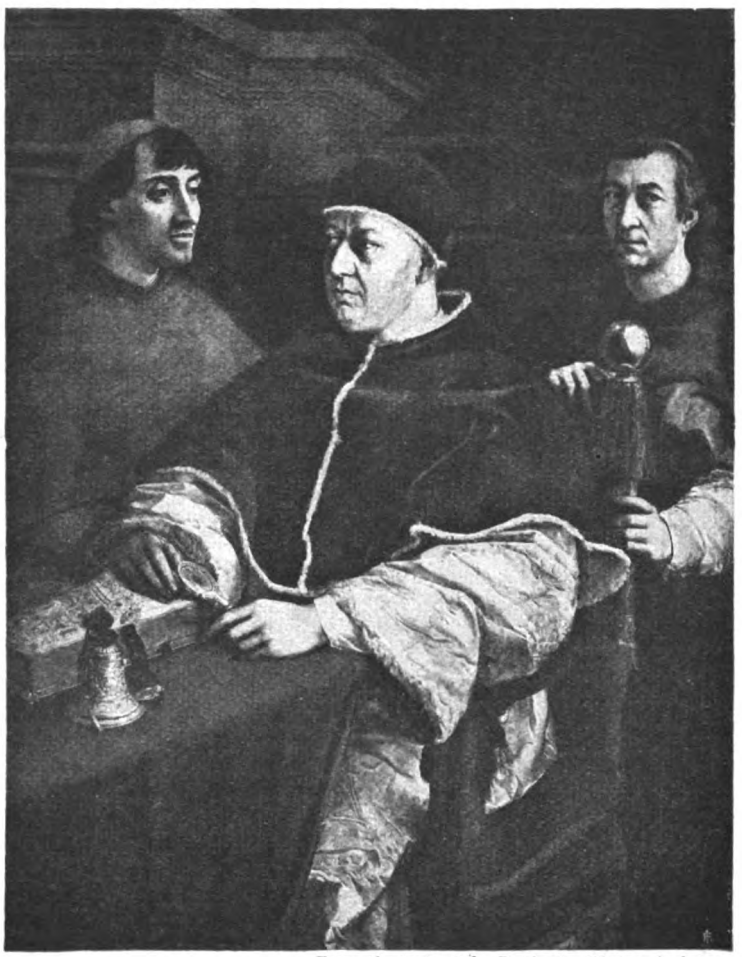
Luther, at that time a faithful son of the Church, was terror-stricken by all that he saw. He remained only a fortnight in the metropolis of the West; but, in after years, used to declare that he would not have missed the visit for a hundred thousand florins, since without it he would never have seen the full corruption of Rome, and would always have feared doing the Pope an injustice.

Yet the shock which he had experienced in Rome did not immediately detach Luther from the Church. He returned to Germany saddened and astounded, it is true, but still a Catholic. Indeed, in 1512 he became a doctor of divinity, and shortly afterwards Provincial Vicar of Meissen and Thuringia. His blameless life, and his zeal for the maintenance of discipline in the various monastic houses under his supervision, proved the man's perfect sincerity. The gloomy mysticism of his speculations, on the other hand, revealed a nature ill at ease, a nature burdened with a heavy discontent; one, moreover, from which great deeds might be expected, should ever a great occasion force it into a life of action.

Such an occasion arose in 1517, when Pope Leo X. authorised the sale of indulgences in Germany, in order to obtain funds for the rebuilding of St. Peter's at Rome.

The Papal commission for the sale of these indulgences in Saxony was addressed to Albert, Elector of Mainz and Archbishop of Magdeburg, who appointed as his agent a Dominican monk, named Tetzel. The latter, an able but thoroughly unscrupulous man, grossly exceeded his powers in executing the task entrusted to him. Seeing that he could make large sums of money out of his commission, he proceeded to do so; and his master, who was very heavily in debt, gave every encouragement, in order that he might divert a substantial part of the proceeds into his own pocket.

The extravagance of the inducements



From the portrait by Raphael. Photo: Anderson.

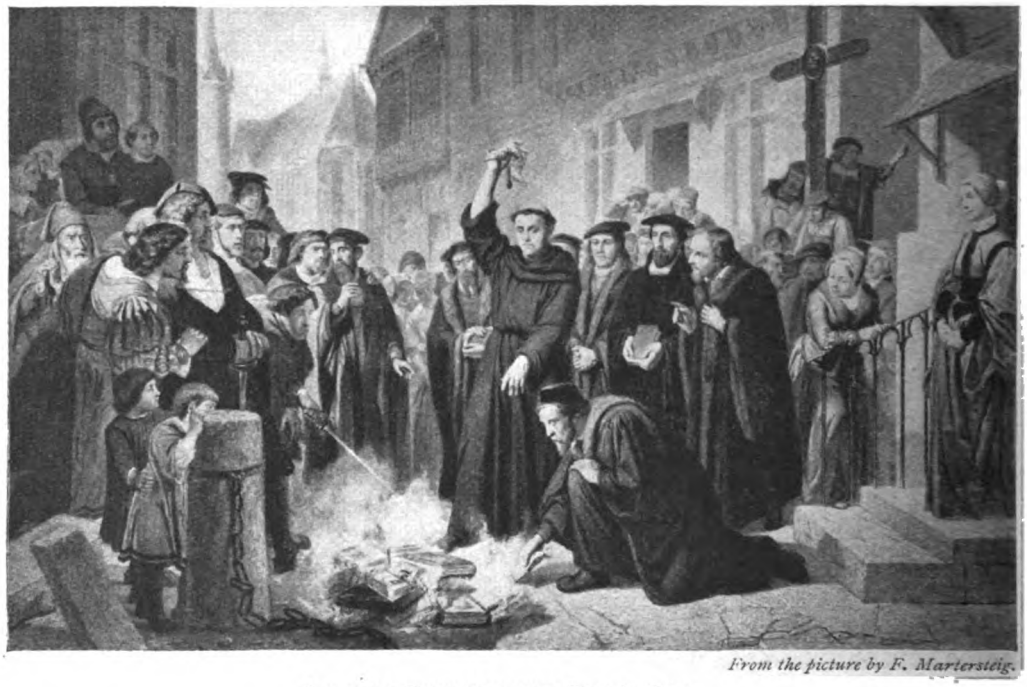
POPE LEO X. (1513-21),

who, in order to raise funds for the rebuilding of St. Peter's, authorised the sale of indulgences which led to Luther's attack on the Roman Church.

held out by Tetzel in order to persuade people to buy his wares soon aroused the indignation of Luther. The monk absolutely denied the efficacy of Tetzel's indulgences. Tetzel replied in equally strong terms. The matter between them was thus brought to an issue; and Luther felt himself the more free to act in that the Elector of Saxony expelled Tetzel from his dominions—not, indeed, from any exalted motive, but merely because the persuasions of the Papal agent were diverting to a foreign country much of the gold and silver of his subjects.

power only to remit the former. Further, he maintained that no indulgences could affect the condition of the dead; and that true contrition of heart, and actual amendment of life, would secure pardon without any indulgence. In fact, though still a Catholic and a monk, he gave expression to the distinctly Protestant conception of man's direct responsibility to God.

The publication of these theses roused much interest everywhere in Germany. Luther's arguments, moreover, impressed men to such an extent that Tetzel found



From the picture by F. Martersteig.

LUTHER BURNING THE POPE'S BULL

in the streets of Wittenberg (1521). This act marked the reformer's formal breach with the Roman Church.

Undeterred by this, Tetzel established himself in a village on the border. Thither went many of the Saxons to him with their coin, and came away with his indulgences. On October 31, 1517, therefore, Luther—confident that his action would meet with no opposition from the Elector—nailed up on the door of the church at Wittenberg a document in which he set out ninety-five theses, or propositions, concerning indulgences.

Luther argued that there was a great distinction between the penalties inflicted by the Church on the penitent sinner and the penalties required, here or hereafter, by divine justice; and the Pope, he said, had

his trade suddenly falling off. In the petulant manner of those days, he then publicly burned the propositions of Luther. The students of Wittenberg replied by burning the counter-propositions of Tetzel.

Pope Leo X., in the seclusion of the Vatican, smiled cynically when he heard of the controversy. Though head of the Church, he had little belief in any of the Church's doctrines, and was vastly amused by what he regarded merely as a foolish quarrel between two monks. Before long, however, finding that Luther's influence was likely seriously to affect his revenues, he deemed interference necessary and summoned the rebellious monk to appear before

him at Rome. The Elector of Saxony then intervened, and obtained for Luther the concession of being examined at Augsburg, within the bounds of Germany.

The result of this preliminary inquiry was inconclusive. Luther, therefore, unwilling to accept such a decision, appealed, in November, 1518, to a General Council of the Church. But in the following March, yielding to pressure brought privately to bear upon him by the Pope, he acknowledged that he had carried his zeal too far.

His controversial animus thus was for a while suspended. It was the reopening of the strife by his opponents which brought him again into the field.

During the summer of 1519, Luther accepted an invitation from the University of Leipsic to attend a great debate upon Free Will—the most vexed and difficult question, perhaps, in the whole range of metaphysics. Dr. Eck, a distinguished theologian, who opened the debate, expressed opinions which ultimately turned the discussion into a dispute about the true headship of the Church. Eck said that the head of the Church was the Pope. Luther maintained that there was One higher; and, now that his old animosity had been rekindled, proceeded to publish several works denying Papal supremacy.

The movement which Luther started in 1517 had, during the period of his silence, been steadily gathering force; and, now that he stood a confessed revolutionary, he found himself at the head of a large following. Not merely the populace, but thinkers, such as Erasmus, Ulrich von Hutten, and Melanchthon, rallied to his cause; whilst even the Elector of Saxony, who formerly had been an ardent supporter of Rome, addressed a solemn warning to the Pope that, should force be used to suppress the monk, that force would be met by force.

This was written on April 1, 1520. Five days later Luther himself addressed a personal challenge to the Pope; and Leo X., for all his indifference and innate scepticism, had no choice but to accept it.

In June, 1520, he condemned the works of

After the painting by Labouchère.

LUTHER TRANSLATING THE BIBLE,

assisted by Melanchthon and Pomeranus. Luther began his great work of translation in 1521 at Wartburg, where the Elector of Saxony kept him, an honoured prisoner, after he had been outlawed by the Edict of Worms.

the rebellious German as heretical, and ordered them to be publicly burned. At the same time, he bade Luther himself to retract within a space of sixty days, under pain of excommunication.

But Luther refused to retract. On the contrary, he retaliated by publicly burning the Papal bull in the streets of Wittenberg.

The reformer's supporters in northern Germany now began steadily to increase both in numbers and in enthusiasm ; and, although Luther had been pronounced a heretic by the head of the Church, hardly a prince or ruler in Germany could be found willing to publish the Papal bull against him, or to take steps to effect his arrest. To the general rule, however, there was one notable exception.

The young Emperor, Charles V., although he fully realised how corrupt was the Church, and how urgent was the need of reforming it, had no intention of sanctioning any change of doctrine. If the Germans once broke with the Pope, he feared that their next step would be to declare themselves independent of the Emperor. He, therefore, immediately published the bull.

His advisers urged him to be cautious. The reformer's doctrines, they said, had sunk so deeply into the hearts of the people that drastic measures would undoubtedly prove dangerous. Before proceeding further, therefore, the Emperor decided to summon Luther to appear before the Diet of Worms, and there to allow him to recant.

Edict of Worms

The reformer's journey from Wittenberg to Worms brought out in striking colours the extraordinary effect which Luther had produced on the people of northern Germany. The town of Wittenberg presented him with a coach in which to travel. The citizens of Erfurt went forth in hundreds to greet him. Everywhere he was received like a monarch or a hero ; and when at last he arrived at Worms, on April 16, 1521, was conducted to his lodgings by a body of nobles and distinguished citizens.

His first appearance before the Diet caused himself and his supporters some disappointment ; but he soon recovered from his initial fear and hesitation, and, having regained confidence, firmly and finally refused to make any recantation.

The Emperor then delivered judgment. It was, of course, entirely adverse. Luther, however, by virtue of a safe conduct which previously had been granted to him, was allowed to depart unmolested. Popular opinion was so manifestly with him that even Charles V. saw the need of acting with caution.

But so soon as Luther had got safely away, the Diet unanimously approved a measure known as the Edict of Worms—the last passed by the Empire in obedience to the decrees of the Pope. This edict described Luther as a heretic, and formally outlawed him, and declared that anyone who sheltered him, printed or published his books, or bought or read them, should also incur that penalty.

Luther's return journey from Worms was distinguished by the same enthusiasm which had marked his triumphant progress thither. But, as he was driving through some woody country near Altenstein, his carriage suddenly was stopped by a body of armed horsemen, and he himself carried off into the forest.

At Wartburg

This seizure was a device of Luther's friend, the Elector of Saxony, who, fearing he might not be able to protect the reformer now that the ban of the Empire had been laid upon him, resorted to this method of removing him from danger. After travelling through the woods for some hours captors and captive arrived at the castle of Wartburg, near Eisenach. Here, for nearly a year, Luther was kept an honoured prisoner ; and it was then that he began his great work of translating the Bible.

Intense study, want of sufficient exercise, and the heavy feeding to which he was always addicted, seem, during this period of seclusion, to have had a permanently injurious effect on Luther's health, and to have increased the brooding melancholy which was always an element in his nature. Yet, on the whole, it was one of the happiest periods in his stormy life.

It was a period of rest and quiet study ; a period of safety from the open violence and from the secret plots of his enemies ; and when at length he emerged from the walls of his friendly prison, it was with a new and stronger determination to face the struggles still before him.

* * * *

Almost immediately after the passing of the Edict of Worms, Charles V. left Germany. Nearly ten years elapsed before he again visited the country. The affairs of Spain, and a succession of wars in various parts of his dominions, fully occupied his attention in the meanwhile. Yet, during those ten years, there occurred in Germany happenings of supreme importance to the whole of Christendom.

J. A. B.

Continued from page 156.

SCIENCES:

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CHEMISTRY.—XX

Sulphur and Hydrogen Sulphide.—SULPHUR is a light-yellow, brittle and combustible element which is found native in volcanic districts, e.g. in Italy, Iceland, Sicily and Japan. Enormous deposits occur in the United States, notably in Texas and Louisiana. Not all the free sulphur found in nature is of volcanic origin, much of it has been formed by the reduction of mineral sulphates by organic matter, and probably in many cases it is derived from the vital processes of specific bacteria.

In the combined state, sulphur is met with as sulphates, e.g. gypsum, $CaSO_4,2H_2O$, and Epsom Salts, $MgSO_4,7H_2O$; as sulphides, such as iron pyrites, FeS_2, and galena, PbS; as hydrogen sulphide and sulphur dioxide gases; and as a constituent of matter associated with life, e.g. albumen and oil of mustard.

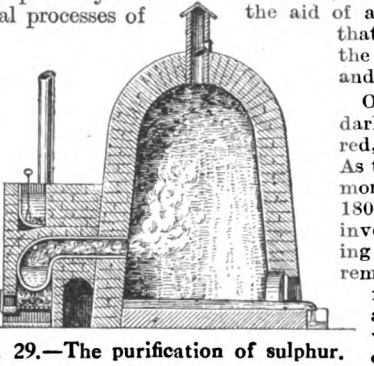


Fig. 29.—The purification of sulphur.

The impure native sulphur is separated from adhering earthy matter, either by massing it in heaps, setting fire to a portion and allowing the molten element to flow away into prepared channels, or by melting *in situ*. In this process two concentric tubes are driven into the mineral, super-heated steam is forced down one tube and the molten sulphur is expelled upwards through the other.

The crude material is then purified by distillation. The molten element is run into an iron retort which is heated by the hot gases from a fire placed below it, and the vapour is condensed in a large brick chamber. When the latter is cold, the sulphur is deposited as a finely-divided yellow powder, "flowers of sulphur," but when the chamber gets hot and above 114° C., liquid sulphur collects on the floor; this is run out into cylindrical moulds and on solidification "roll sulphur" is obtained. This phenomenon affords a parallel to that observed when water vapour is cooled; at and below 0° C. snow is formed, but above 0°, liquid water collects.

Experiment LX.—*The action of heat upon Sulphur.*

(i) A large test-tube is filled with sulphur and supported vertically by a clamp on a retort-stand. A bunsen flame is wafted about around the tube to heat it as uniformly as possible. It will be observed that some portions of the sulphur melt long before other parts, showing that it, like most non-metallic elements, is a bad conductor of heat. With the aid of a thermometer it will be found that the melting point is 114°, and the molten element is light yellow and very mobile.

On further heating the sulphur darkens, passing through orange, red, and brown to almost black. As the temperature rises it becomes more and more viscous so that at 180° the test-tube can be nearly inverted without the contents falling out. Above 180° the liquid remains nearly black but it becomes mobile again. At 444° it boils and gives off a dark red-brown vapour, and around the mouth of the tube will be found some flowers of sulphur. The sulphur vapour will catch fire as it enters the air, burning with a lilac-blue flame and forming sulphur dioxide gas and some white fumes of sulphuric acid.

(ii) To illustrate the refining of sulphur by distillation, the element may be boiled in a retort of which half the neck has been broken off; a strong flame is required. Sulphur vapour will burn at the end of the neck, and the liquid which condenses there may be allowed to drip into a beaker of cold water, when it will be suddenly cooled and converted into a tough, elastic mass—plastic sulphur. The density of sulphur vapour at 500° is 96_4, relative to hydrogen its molecular weight is therefore $2 \times 96 = 192$. Dividing this number by the atomic weight 32, we get $192 \div 32 = 6$, i.e. at 500° the sulphur molecule is hexatomic; it is represented by S_6. Further, the density is found to decrease as the temperature increases, and at 1,000° it equals 32, corresponding to a molecular weight of 64. Now $64 \div 32 = 2$,

therefore at 1000° sulphur is diatomic—S_2. The reversible equation $S_6 \rightleftarrows 3S_2$ represents this change. The molecule of solid sulphur is believed to contain 8 atoms—S_8.

Combination with Metals.—Sulphur unites readily with most metals, forming sulphides, which can also be regarded as salts of the acid, hydrogen sulphide, H_2S.

Experiment LXI.

(i) Sulphur is boiled in a test-tube [as in LX. (i)] and a narrow strip of clean, thin copper foil is lowered into the vapour. Incandescence ensues and black copper sulphide is formed.

(ii) Small quantities of the element may be heated with metals, e.g. tin, iron and magnesium, in narrow hard glass tubes, and the sulphides produced carefully examined.

(iii) Flowers of sulphur with about six times the weight of mercury are rubbed together in a mortar, a little caustic potash or soda being added to aid the combination; black sulphide of mercury, HgS, results.

(iv) A very small quantity of sulphur is heated on a silver coin; a black stain of silver sulphide, Ag_2S, is produced. This (also the action of heat) constitutes a very good test for free sulphur. If the element be pure no residue is left when it is burnt or volatilised.

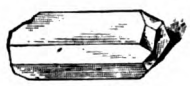


Fig. 30. Monoclinic Sulphur.

Fig. 31.—Rhombic Sulphur.

Sulphur combines also with many non-metallic elements besides oxygen, e.g. with carbon, phosphorus, and hydrogen. Carbon disulphide is a colourless, oily, foul-smelling liquid made by passing sulphur vapour over strongly heated charcoal or coke, and condensing the vapour in long condensing coils. It boils at 46° and the vapour is very inflammable. Sp. gr. 1.29.

Allotropy.—On examination flowers of sulphur is found to contain about 70 per cent. of a crystalline form, known as "rhombic" or "octahedral" sulphur and soluble in carbon disulphide, and about 30 per cent. of an amorphous form insoluble in that reagent. On the other hand, roll sulphur consists almost entirely of the first named. These two forms of sulphur together with plastic sulphur differ from one another in physical properties only, e.g. sp. gr., melting-point, solubility; chemically they are identical. They are called "allotropes" of sulphur, and the element is said to exhibit "allotropy." There are many other allotropes of sulphur besides the three mentioned, but they are of no great importance. The following summary will serve to emphasise the physical differences between the common allotropes.

	A. *Rhombic.*	B. *Monoclinic.*	C. *Plastic.*
Colour	yellow (bright)	yellow (amber)	yellow (amber)
Sp. Grav.	2·04	1·93	1·95
Melting Point	114·5°	120°	—(changes to rhombic)
Solubility in CS_2	soluble	soluble	insoluble
Malleability	brittle	brittle	malleable
Crystalline form	crystalline	crystalline	amorphous.

Experiment LXII.—*Preparation of allotropes of sulphur.*

(i) Rhombic sulphur is obtained by dissolving crushed roll sulphur in carbon disulphide and allowing the clear solution to evaporate slowly. Fig. 31.

(ii) Monoclinic sulphur is conveniently made by melting the element in a fire-clay or porcelain crucible and allowing it to cool very slowly. At the moment of solidification long needle-shaped crystals are observed on the surface, and if this thin crust be pierced immediately, and the still molten interior poured out and the crust cut open, a mass of crystals will be found inside.

(iii) Plastic sulphur was obtained in LX. (ii). It is produced more easily by heating the element in a dish up to 180° or above and pouring it in a thin stream into a beaker or other vessel containing cold water. This allotrope is not formed unless the temperature be 180° or above and the cooling be sudden.

Under ordinary conditions of temperature and pressure, rhombic sulphur is the most stable, and the other allotropes slowly change back to this form. Plastic sulphur is unstable at all temperatures, particularly at about 100°, but monoclinic sulphur is permanently stable between 96° and 119°; below 96°, rhombic is the most stable. The temperature 96° is called the "transition" temperature between rhombic and monoclinic sulphur—for at this temperature the two forms are mutually convertible, and without change in weight.

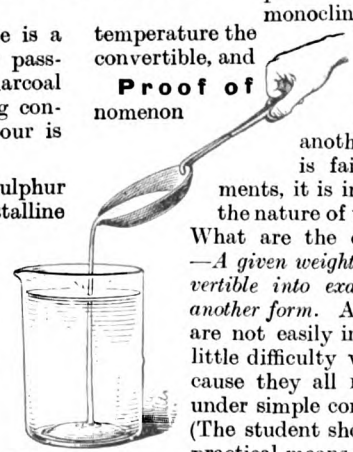


Fig. 32.—Preparing Plastic Sulphur.

Proof of Allotropy.—As the phenomenon of allotropy (Gr. allos=another, tropos=shape or form) is fairly common among elements, it is interesting to inquire as to the nature of the evidence concerning it. What are the criteria of allotropy? A.—*A given weight of one form should be convertible into exactly the same weight of another form.* Allotropes of some elements are not easily interconverted, but there is little difficulty with those of sulphur, because they all revert to rhombic sulphur under simple conditions of experimenting. (The student should be able to suggest the practical means of establishing the chemical identity and allotropy of the three modifications of sulphur.) B.—*Equal weights of different forms should yield, on combustion, the same weight of the same product,* in this case, sulphur dioxide.

From the equation $S+O_2=SO_2$, it is obvious that the weight of sulphur dioxide produced is exactly double the weight of the sulphur burnt, and exact experiments give this result. The following experiment will give a satisfactory result to a careful worker; any discrepancy between the actual and theoretical results will be due to the formation of a little sulphur trioxide, SO_3.

Experiment LXIII.—*To prove the allotropy of sulphur.*

A gas holder is filled with oxygen by making it displace and force the water filling the bottle B into

the funnel A; this is accomplished by passing the oxygen, preferably from a cylinder of compressed gas, through the lower tap C. The gas is dried passing through two wash-bottles D, containing conc. sulphuric acid, and thence through the hard glass tube E, supported on a Ramsay furnace, into which a small porcelain boat containing the weighed sulphur (0.1-0.2 grm.) is inserted. The sulphur dioxide is absorbed in two U-tubes containing respectively moist solid caustic soda and soda lime, which are weighed before and after the combustion. It is essential that the tube should be heated slowly and that the oxygen current should be very gentle at first; later the temperature and the current may both be increased. Also, care must be taken that all the sulphur is burnt, that e.g. none volatilises and remains in the cooler part of the tube. If the sulphur used be not pure, the weight of the residue remaining in the boat after combustion must be subtracted from the weight of sulphur taken. It is found that equal weights of the different allotropes yield the same weight of products.

Fig. 33.—To prove the allotropy of sulphur.

Sulphur is used for vulcanising rubber, for making gunpowder, carbon disulphide, as an insecticide, and as a constituent of pharmaceutical preparations. The largest quantities are used for making sulphuric acid, sulphur dioxide and sulphites.

Hydrogen Sulphide or Sulphuretted Hydrogen.—Sulphur and hydrogen do not readily combine and the product of their union—hydrogen sulphide H_2S—is comparatively unstable, particularly towards heat. Combination is effected by passing sulphur vapour and hydrogen together through a heated tube, or by passing hydrogen through molten sulphur; but owing to the fact that the reverse action begins at 400°, the yield is poor. $H_2+S=H_2S$. A better method of preparation is to act upon a metallic sulphide with a non-oxidising acid, and the usual process is to decompose ferrous sulphide FeS (not to be confused with iron pyrites FeS_2) with hydrochloric or a diluted sulphuric acid. $FeS+2HCl=H_2S+FeCl_2$; $FeS+H_2SO_4=H_2S+FeSO_4$. The reaction takes place at the ordinary temperature.

Experiment LXIV.—*To prepare and examine hydrogen sulphide.*

(i) The apparatus used for making hydrogen is employed. The heavy sulphide is carefully put into the flask and conc. hydrochloric acid is poured through the funnel. The gas is collected either by downward displacement or over warm water. (ii) The pungent smell of the gas will be observed *nolens volens:* it is colourless, invisible and poisonous. (iii) A light is applied to the mouth of a jar: the gas burns with a blue flame forming water and sulphur dioxide, but there is a deposit of sulphur inside the jar as there is insufficient oxygen there to oxidise the gas completely. (iv) A lighted taper is extinguished when put into the gas. (v) Silver leaf is quickly tarnished owing to the formation of black silver sulphide. (vi) A jar is inverted in water: the latter rises slowly as the gas is dissolved. A solution may then be prepared by passing the sulphide directly into water. (vii) The solution should be tested with litmus, and then (viii) added to solutions of lead nitrate, copper sulphate, and ferrous sulphate.

The smell of sulphuretted hydrogen resembles that of rotten eggs; it is actually evolved when eggs or other albuminous matter containing sulphur undergo putrefaction. The action involved when the gas is burnt in a plentiful supply of air is: $2H_2S+3O_2=2H_2O+2SO_2$, but when the oxygen is deficient: $2H_2S+O_2=2H_2O+2S$. It is moderately soluble in water, 1 volume of water dissolving 4·37 volumes at 0° C., and 3·23 vols. at 15°. The solution does not keep well as it becomes oxidised to water and sulphur. It is only a weak acid yielding salts called "sulphides." Many metallic sulphides are insoluble in water and hence are readily precipitated when hydrogen sulphide acts upon a soluble salt, e.g. $Pb(NO_3)_2+H_2S=PbS+2HNO_3$; $CuSO_4+H_2S=CuS+H_2SO_4$.

The sulphides of sodium, potassium and ammonium are all soluble and may be made by direct action between hydrogen sulphide and the hydroxides. The reducing action of this compound must not be overlooked. It decomposes sulphuric acid: $H_2S+H_2SO_4=S+2H_2O+SO_2$, and for this reason cannot be dried with this acid (phosphoric oxide is used instead): it reduces nitric acid to oxides of nitrogen and water: and it reduces chlorine by causing it to combine with hydrogen, $H_2S+Cl_2=2HCl+S$. An element is said to be reduced when it unites with hydrogen. Hence dilute chlorine is a good antidote for sulphuretted hydrogen. E. H. T.

LIGHT.—VIII

23. Spectrum Analysis.—THE spectrum of a body often throws conclusive light on its physical and chemical nature. Thus it is found that an incandescent solid always gives a continuous spectrum, while glowing vapours yield spectra composed of bright lines only. The spectrum of the limelight is continuous; that of a Bunsen flame in which a little salt has been sprinkled shows one bright yellow line (in a good spectroscope two), and nothing more. These *line spectra* are characteristic of the elements present in the flame.

Place a Bunsen flame opposite the slit of a spectroscope, and examine the spectrum produced when the chlorides of sodium, potassium, lithium, strontium, and calcium respectively are sprinkled successively in the flame. Does the spectrum connect itself at all with the visible colour of the flame?

Metals like iron, magnesium, and others whose salts do not become volatile in the Bunsen flame have to be examined with the electric arc. Gases, like hydrogen or oxygen, can be made luminous when they are enclosed at low pressures in vacuum tubes, and subjected to the electric discharge. In each case characteristic spectra are produced.

The most interesting spectra are the *absorption spectra* yielded when white light is passed through absorbing media. What would be a continuous spectrum is crossed by dark bands indicating what light has been absorbed. The absorption spectrum

is often perfectly characteristic of the liquid, e.g. hæmoglobin, the red colouring matter of the blood, and chlorophyll, the green colour of plants,

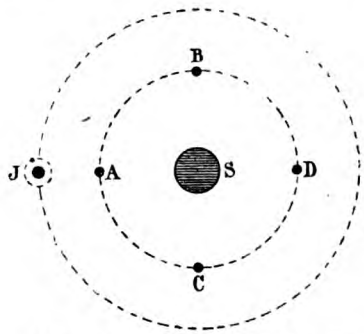


Fig. 75.—To illustrate Römer's method of determining astronomically the velocity of light.

each yields a recognisable and characteristic absorption spectrum.

When the *solar spectrum*, or spectrum of sunlight, is examined, it appears at first to be continuous; but more careful examination shows it to be crossed by a large number of dark lines, known as *Fraunhofer's lines*. It is therefore an absorption spectrum. It is found that very many of these lines correspond in position to the bright lines given by the incandescent vapours of well-known elements. Thus, there is a dark line in the yellow (really double), known as the D line, which corresponds exactly in position with the bright yellow line given by glowing sodium vapour. The fact that the line is dark indicates absorption, due to sodium vapour; but where? The following experiment due to Kirchhof suggests the answer:

Obtain in a spectroscope the continuous spectrum of a very bright source of light, such as the lime-light or the electric arc. Between the light and the slit place a Bunsen burner, so that the light which enters the spectroscope has to pass through the yellow flame. The *dark* line in the yellow will then be seen. Replace the limelight by an ordinary gas flame: the dark line is no longer seen, but the yellow is noticed to be much brighter than the rest of the spectrum.

It would thus appear that the sodium flame can and does absorb the exact kind of radiation that it emits, provided that it comes from a hotter source. We therefore picture the sun with an incandescent core giving a continuous spectrum; the light from this then passes through an atmosphere, very hot, but cooler than the core; and in this atmosphere occur the glowing vapours of sodium, magnesium, iron, and some forty or fifty other elements, whose characteristic lines occur in the solar spectrum. In this way the spectrum of the sun throws much light on its physical and chemical nature. The fixed stars also have yielded to the same test; and some of them are found to be like the sun in constitution, while others are more nearly gaseous, and much simpler in their chemical nature.

24. Velocity of Light—Astronomical Methods.—Though earlier attempts had been made to establish the finite speed of light, it was not until 1676 that a Danish astronomer named Römer settled the point conclusively by obtaining an approximate value for it. The moons of Jupiter are eclipsed at each of their revolutions round the planet owing to the fact that the planes of their orbits nearly coincide with that of Jupiter's itself. Observing the interval between successive eclipses of one of the moons, Römer found that this interval was not always the same; and after a long series of observations he realised that the variation was due to the change in the relative positions of the earth and Jupiter. A reference to Fig. 75 will make this clear. Suppose J to be the position of Jupiter in its orbit; it is obvious that when the earth is at A it is much nearer to J than when it is at B, C, or D.

Now, suppose two observations of the moon to be made at D, and the interval between two successive eclipses found. It is a little more than 48 hours, and during that time the earth has been moving nearly at right angles to J D; its distance from J has not changed much, and we may regard the interval observed at D as the true one. Now, as the earth moves through B to A, the occurrence of the eclipse, calculated from the observation at D, is always a little in advance of the expected time; and by the time the earth reaches A the eclipse takes places 16½ minutes too soon. If light travels with a finite speed, this is readily explained. For light is, as it were, the messenger which announces the eclipse; if we go to meet the messenger, as we are supposing the earth to do, we receive the news earlier than if we had awaited his arrival.

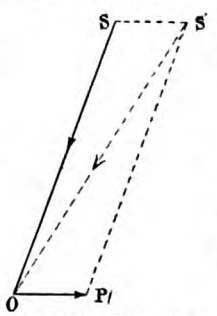


Fig. 76.—To illustrate Bradley's method.

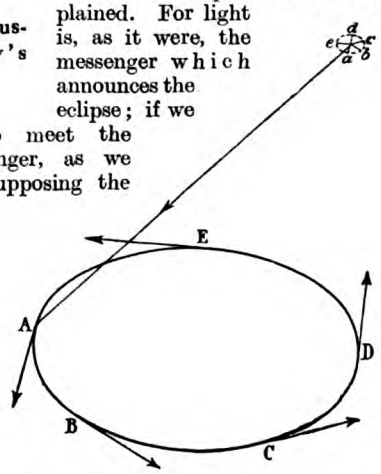


Fig. 77.—Determining the relation between the velocity of the earth and the velocity of light.

Hence the 16½ minutes represents the time taken by light to cover the distance A D, which is about

ILLUSTRATING THE PRINCIPLES OF THE SPECTROSCOPE,

which splits up the rays of light from the sun or a star into a coloured band. Spectrum analysis is of great scientific value, the spectrum often providing conclusive evidence as to a body's chemical and physical nature.

186,000,000 miles. From this the speed of light works out at $\frac{186,000,000}{16\frac{1}{2} \times 60}$ miles per sec. = about 188,000 miles per sec.

The second method of determining the velocity of light was found by Bradley, an English astronomer, in 1723. He discovered that all the fixed stars were subject to an annual variation of their position, now known as *aberration*; and successfully calculated the velocity of light from his observations. In order to understand the principle involved, imagine yourself walking sharply in a vertical shower of rain. It is a familiar fact that, under these circumstances, the rain beats into the face, and appears to be coming obliquely towards you. The faster you walk the more pronounced does this change of direction become.

Now, the light of the stars is analogous to the shower of rain. To an observer on the earth, moving with the earth in the direction O P (Fig. 76), the direction of the star light, S O, seems to be changed to S′O and the position of the star is displaced apparently to S′. This displacement, it will be noticed, is in the same direction as the observer is moving. As, then, the earth moves in different directions at different points in its orbit, the star will, as a result of aberration, occupy a series of positions, A, B, C, etc., on a small ellipse corresponding to the earth's orbit. The angle made at the earth by the semi-major-axis of this ellipse is called the constant of aberration. If it is measured, the relation between the velocity of the earth and the velocity of light can be determined (Fig. 77).

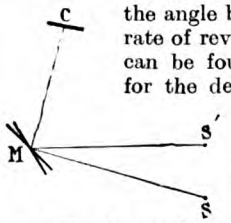


Fig. 79.—Foucault's method.

Bradley's process is now chiefly of historical interest, since the velocity of light can by other means be measured more accurately than the constant of aberration. For this constant is, owing to the great speed of light, a very small quantity (about $20\frac{1}{2}''$); and the fixed stars are subject to other small displacements, due to refraction, parallax, precession, and so on, which makes an accurate determination of any one of them a matter of great difficulty.

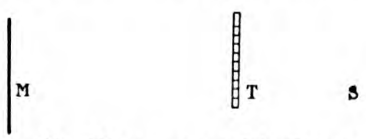


Fig. 80.—Diagram to explain Fizeau's method of determining the velocity of light.

25. Velocity of Light—Terrestrial Methods.—The two methods by which the velocity of light has been accurately obtained are among the greatest triumphs of practical physical science. Suppose an observer A has a light at, say, a distance of 10 miles from an observer B; and suppose at some preconcerted moment A covers up the light, and B records the time when he sees him do so. The interval between A's act and B's perception of it would be about 1-18,000th second, and it is the successful measurement of this small interval that is in question.

Fizeau's method was the first to solve it satisfactorily, and its essential feature can be readily understood (Figs. 78 and 80). M is a mirror so arranged as to reflect back the light from the source S along the same path as it originally pursued. T is a toothed wheel, so fixed that the light from S passes through one of the spaces between the teeth. If this wheel is then at rest an eye behind S will see an image of S reflected in the mirror M. Now suppose the wheel to be set in rotation gradually.

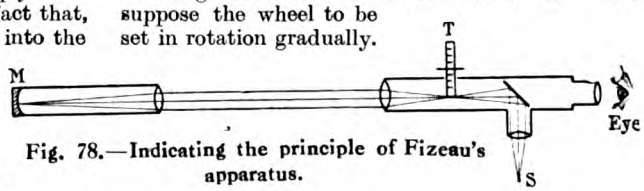


Fig. 78.—Indicating the principle of Fizeau's apparatus.

As the speed increases, the light which passes through a space will eventually, on returning from M, strike the next tooth, and at that speed the eye will see no image in the mirror. Increasing the speed still further, the returning light will be able to get through the next space, and at that point we have the light performing the journey from T to M and back, while the wheel is turning through the angle between one space and the next. If the rate of revolution of the wheel is known, this time can be found, and hence the material necessary for the determination of the velocity of light is available.

The elaborate details necessary for the successful performance of this experiment turn upon two main pivots: the necessity, owing to the fact that T M must be 3 or 4 miles, for the conservation of the light; and the separation of the source, S, from the observation part of the apparatus. Fig. 78 will indicate how these points are dealt with.

The source of light S enters a telescope tube sideways, and the light from it falls from a small piece of thick glass placed at an angle of 45° in the tube, and between the eye-piece and the object-lens. The light reflected from this glass is focused on the teeth of the toothed wheel which also works in the telescope tube. The object-lens of the telescope is so arranged that a parallel beam of light emerges from it, and this falls on another lens fixed in a tube at the far end of which is a concave mirror placed so that the lens is at its centre of curvature. By this arrangement the light returns along its original path, and is viewed by the eye-piece in the first telescope. The two tubes are 3 or 4 miles apart and their optic axes must coincide.

In the very careful experiments of Cornu by this method, undertaken with every refinement, the velocity came to a little over 300,000,000 metres, or about 186,420 miles per sec., which is now thought to be a little too high.

Foucault's method is no less simple in principle, and calls for no less delicate manipulative skill in its operation (Figs. 79 and 81). The small interval of time is in this case obtained by means of a revolving mirror, M. A pencil of rays from a source of

light, S, is reflected from M on to a distant mirror, C, and made to retrace its course. If M is at rest therefore, an image of S will return to S. But if while the light is travelling from M to C and back,

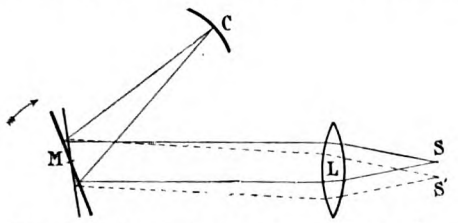


Fig. 81.—Showing the action of Foucault's apparatus.

the mirror M is turned through a small angle, the return ray will be diverted into the direction M S^1, and an image of S will be formed at S^1. As the distance S S^1 can be measured, the angle S M S^1 can be found, and this is double the angle turned through by the mirror. Hence we know the angle through which the mirror has rotated while light travels twice the distance M C. The rate of rotation of the mirror being known, we have the necessary data for determining the velocity of light.

In 1880, Foucault's method was much improved by Michelson in America, and a little later Newcomb obtained the best result yet recorded for the velocity of light. He gave 299,860,000 metres, or 186,330 miles per sec. E. W. E.

ELECTRICITY AND MAGNETISM.—VIII

Volta and Galvani.—CURRENT electricity produced by chemical means is sometimes termed Galvanic or Voltaic electricity on account of the earliest investigations in the subject being performed, towards the close of the 18th century, by two Italian scientists named Galvani and Volta respectively. The former was a physician who experimented upon the nervous systems of recently killed frogs, and found that when two bars of dissimilar metals were in contact at one end, and touching a frog's nerve at the other ends, muscular contraction took place. He believed that electricity was generated by the frog. Volta, a professor of physics, took a different view of the matter and concluded that the production of electricity was due to the contact of dissimilar metals, a theory, the correctness of which he proved by constructing an apparatus that has been termed the Voltaic Pile. Discs of copper and zinc were arranged one on top of another in the form of a pile. A disc of zinc was separated from one of copper by a similar disc of flannel soaked in brine. The brine in the flannel acted in manner similar to that of the sulphuric acid in the simple cell. Several of these zinc and copper couples, with their intervening flannel discs, were piled above one another in such a way that the copper of one couple was in contact with the zinc of the next couple. The whole arrangement, consisting of many couples, yielded a current when the zinc of the top couple was connected by a wire with the copper disc of the lowermost couple. The current derived from the pile was too feeble to be of much use, but the apparatus proved Volta's contention regarding the contact of dissimilar metals.

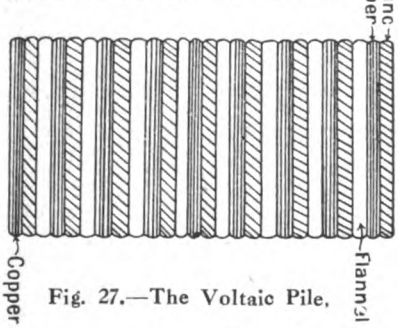


Fig. 27.—The Voltaic Pile.

The Simple Cell.—Volta also invented the simple cell, which we must next consider.

Experiment 24. — *To note the chemical action between zinc and sulphuric acid.*

Put a small piece of ordinary impure zinc into the glass jar, and pour into the jar sufficient of the acid solution to cover the zinc completely. The fragment of zinc should be smaller than that of a pea, or it will require too much solution to dissolve it entirely. Notice the brisk effervescence due to the escape of hydrogen gas. Carefully smell the escaping gas and notice that it has rather an unpleasant odour. You will observe that the zinc becomes smaller and smaller as the effervescence continues, and that minute fragments of black material are present in the solution. If necessary add more acid until the zinc has completely disappeared.

In performing this experiment we noticed that

(1) The zinc disappeared.

(2) A gas having an unpleasant odour was evolved.

(3) Fragments of a black material appeared.

How do we explain these chemical changes?

Firstly, the composition of sulphuric acid must be described. In this acid three chemical elements are present:—hydrogen, oxygen, and sulphur. When these substances are not combined with one another, the first two are gases at ordinary temperature, and the third is a yellow solid with which everyone is familiar. Combined together in the proportions hydrogen 2, sulphur 1, and oxygen 4, they form sulphuric acid, which is a liquid.

It will be easily understood that the chemical formula for this acid is H_2SO_4. It is not necessary to write S_1, since S without a figure means one atom of sulphur.

It must be noted carefully that chemical compounds such as sulphuric acid, and others which we shall have to consider, are *not mixtures* of different elements. Hydrogen, oxygen, and sulphur will not produce sulphuric acid when they are merely mixed, even if they are in the necessary proportions.

In any chemical compound, the elements of which it is composed are united by chemical attraction, and the compound has properties quite different from those of its constituent elements.

Chemical action took place only between the acid and the zinc in our experiment. Zinc con-

tains no hydrogen, therefore this gas came from the acid. The zinc has a greater attraction for the oxygen (O) of the acid than hydrogen has, hence the latter was dislodged and its place taken by the zinc with the formation of a substance called zinc sulphate, the formula for which is $ZnSO_4$.

Compare the two formulæ H_2SO_4 and $ZnSO_4$. It is evident that the zinc turns all the hydrogen out of that portion of the acid which reacts with it. As there is plenty of acid, the chemical change displacing hydrogen goes on until all the zinc has been changed into zinc sulphate which dissolves in the solution.

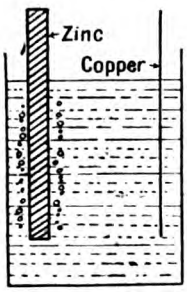


Fig. 28.—Illustrating the action of zinc, copper and sulphuric acid.

Now impure zinc contains other substances such as arsenic, and this explains why the gas had a bad odour, for some of it consisted of a substance known as arseniuretted-hydrogen which escaped with the ordinary hydrogen. Since the escaping gases contain arsenic, the student should be careful not to inhale it. The numerous black fragments found in the solution are solid impurities originally in the zinc.

Experiment 25. — *To see if copper displaces hydrogen from the acid solution.*

Dip the sheet of copper in a fresh portion of the solution, and note that there is no escape of gas.

Why is this ? The copper has less attraction for the oxygen in the acid than hydrogen has, hence the acid remains unaltered.

Experiment 26. — *To note the behaviour of zinc and copper when placed in the solution together.*

Into the same portion of acid used in the last experiment place the copper and zinc so that they are not in contact.

As might be expected, the hydrogen and impure gases escape near the zinc, but the copper is not affected (Fig. 28).

Now connect the ends of the zinc and copper which are out of the solution by means of a wire.

We have seen that under these conditions a current flows along the circuit, and its presence may be indicated by including a galvanometer in the external circuit. But notice what has happened to the escaping hydrogen in the solution. The gas bubbles now escape *near the copper*, and the gas does not appear to escape entirely, many bubbles adhering to the copper plate (Fig 29).

The hydrogen is set free by the action of the zinc on the acid ; then why should the gas escape near the copper when the current is flowing ? Does the gas actually travel through the solution, or is it that the bubbles of gas near the copper plate are not the identical atoms of hydrogen set free near the zinc when the circuit is open ?

Let us consider that we have a number of similar bodies each consisting of elements A and B. We conclude that the chemical formula for each of such bodies is AB.

Suppose that there is a line of these bodies arranged in order from one substance P to another substance Q, in this fashion :—

P—AB, AB, AB, AB, AB, AB—Q.

We must remember that A and B are combined together as a definite substance, but they would be separated, should a substance come along with a greater attraction for B than A has.

Imagine that Q is such a substance.

Q seizes B, whereupon A is set free, and having been just freed from combination with B, it possesses more energy of attraction than usual. Consequently it seizes B of the next AB, and another A is just freed. This in its turn seizes the next B, in the series, and so a process of interchange continues until the last A near P is let loose. This A having no B to seize escapes uncombined, since P will not form a compound with it. Hence the substance A liberated at P is not identically the same as the A originally freed at Q.

During the process of interchange the series becomes P, A, BA, BA, BA, BA, BA, BQ.

Let us compare this with the action of the simple cell.

The zinc combines itself with the SO_4 of the nearest molecule of sulphuric acid, setting free the two atoms of hydrogen (H_2).

This hydrogen being just let loose has more energy than the combined H_2 of the next molecule of acid, hence it seizes the SO_4 and turns out the H_2 of that molecule. This process proceeds through the solution until the last H_2 is liberated in contact with the copper which refuses to combine with it, hence it escapes.

Fresh zinc is constantly coming in contact with fresh acid, hence the interchange of hydrogen is kept going. Now the freed hydrogen bears a charge of electricity, and as the bubbles come in

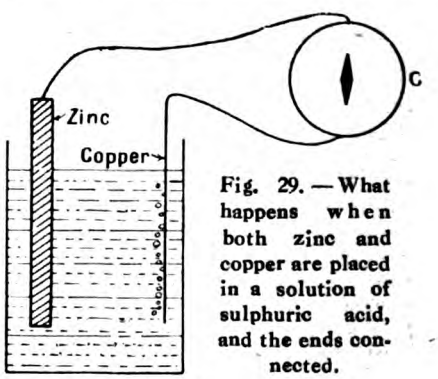


Fig. 29.—What happens when both zinc and copper are placed in a solution of sulphuric acid, and the ends connected.

contact with the copper they impart electricity to it. A constant supply being kept up, a current flows through the circuit, both along the external wires and through the solution.

We can now state that a current of electricity is produced in a simple cell when the circuit is closed (i.e. complete) as the result of the chemical attraction existing between zinc and that part of the acid which enables it to form zinc sulphate ($ZnSO_4$). The interchange of hydrogen atoms takes place only while the circuit is complete, and it is this interchange that conducts the current

across from the zinc to the copper in the solution. Out of the solution the current flows from the copper to the zinc. For this reason the copper is called the *positive* plate, and the zinc is known as the *negative* plate of the cell.

Can any other substance be used in the place of copper in the simple cell ?

Experiment 27. — *To see if carbon will act in the place of copper in an electric cell.*

Procure a piece of carbon, preferably the kind known as graphite, which can be obtained at an electrician's or a gas works.

Fit up the simple cell, using the carbon in place of copper, and note that a current flows along the circuit. When carbon is used, the current is a little stronger than it is when copper is employed ; this fact can be shown by the use of a galvanometer in the circuit.

Polarisation.

Experiment 28. — *To see if the strength of the current of a simple cell is constant.*

Fix up the simple cell with a galvanometer in the external circuit. If you have no galvanometer use a compass needle, and see that a portion of the external wires passes over the needle at rest in the meridian. Notice the deflection of the needle when the current starts, and observe how the compass or galvanometer needle slowly moves back towards the original position as time goes on, owing to the weakening of the current.

Why does the current from a simple cell quickly deteriorate ?

It was noticed in a previous experiment that some bubbles of hydrogen adhered to the copper plate instead of floating to the surface. These adhering bubbles form a fine layer of non-conducting gas that prevents the other hydrogen atoms from delivering their electricity to the copper plate, hence the current rapidly weakens and finally may stop altogether.

The very hydrogen that leads to a current at first, later becomes a nuisance, and *no cell can be of much practical use unless it possesses some means of getting rid of the gaseous accumulation on the positive plate.*

This slowing down of the current by the hydrogen nuisance is called *Polarisation*, the positive plate (copper, carbon, etc.) is said to be *polarised*, and the process of preventing polarisation is called *anti-polarisation*. In the next lesson we shall see how the cells in common use effect this riddance of the hydrogen nuisance.

As the exciting liquid of a cell is not obliged to be sulphuric acid, the student might easily construct some simple cells by means of rods of zinc and carbon immersed in a strong solution of sal-ammoniac, a substance that can be obtained from an oil and colour stores. Half a pound of this material costing only a few pence would be sufficient to make solution for several such simple cells. Although the current derived from such cells would be weak, the very slow disappearance of the zinc would be a decided advantage. If sal-ammoniac is unobtainable, a concentrated solution of common salt can be tried. L. M. P.

ZOOLOGY.—XVII

THE Game Birds, as they are termed, belong to an order that includes also the Domestic Fowl in its many variations. Most of the members of this large group are grainfeeders, though the young take insects, and the foot in most cases is well adapted with its curved claws for turning up the soil by which the grain is hidden.

Game Birds

The Capercailzie, termed the Wood Grouse and the Cock of the Woods, now common in certain parts of Scotland, is an interesting example of the reintroduction of a bird that had become extinct in a certain area. Badly as the early members of the race appeared to have fared in these islands, the aliens, who may now by reason of long family residence claim to be naturalised, have greatly increased in numbers. The length of this fine bird runs between two and three feet. Its food consists of the buds of trees and berries.

The Red Grouse, commonly known as the " Grouse," is the bird of sporting fame. It is a hardy resident inhabiting the Northern parts of Britain, where it nests in the stunted plants of the bleak moors.

The Black Grouse is better known to many by the title " Black Cock " which is borne by the male bird, the title " Grey Hen " given to the female is less likely to be recognised since only the male bird is of interest to sportsmen. The Black Grouse, once common in all parts of Great Britain, is now rarely seen save in Scotland and in the wilder parts of England and Wales.

The Ptarmigan is far more general elsewhere in Northern Europe than in Great Britain, where it may only be found upon the bleak Scottish hills. It is a slightly smaller bird than the Red Grouse, and varies in colour from black and white in the summer to grey in the autumn and white in the winter.

The Partridge, a native of Great Britain, is to be found in many European countries. It is very partial to cultivated land, and does good service by eating slugs and harmful insects. Green leaves, grain and seeds also form part of its diet.

The Common Pheasant, though long since naturalised, was originally imported to Britain and other European countries from Asia Minor, and even to-day, in those parts in which the climate is most severe, it would probably disappear very rapidly but for the fostering care of the gamekeeper. Though

the Pheasant is a strong flier, his first thought when threatened by danger is to run, but when at length he takes to flight he does so with a suddenness that causes him to be termed on such occasions a "rocketer." The beauty of his plumage is too well known to need description.

The Ring-necked Pheasant, a recent importation to Britain from China, appears to have become acclimatised here. The Golden Pheasant, justly famed on account of his brilliant appearance, is also a native of China. The Argus Pheasant of Malacca, though smaller than the British bird, attains a considerable length by reason of its plumage, which is less vivid than that of most members of the Pheasant tribe. The Amherst Pheasant, with his vivid red crest and his body colours of black, green and orange, is one of the most beautiful birds imaginable.

The Quail is common to Europe, Africa and Asia, and an occasional summer visitor to Britain. He is a small bird, rarely if ever exceeding the size of a thrush.

The Peacock, like the Pheasant, is an alien domiciled in this country. In a wild state he is only to be found in Asia. Though at one time he was eaten with great relish, he is now kept purely as an ornament, and few who have seen his train spread to the best advantage will be inclined to doubt that he abundantly justifies his position. The greatly developed upper-tail coverts with which his fame is bound up do not appear until the bird has attained his third year.

Brush Turkeys

The Red Jungle Fowl of India is of considerable interest, since it is supposed to represent the original stock from which our domestic fowl has developed. The Red Jungle Fowl is slightly smaller than its European relative, has a red comb, red and black back, and a long blue-black tail. This bird inhabits the forest, but is frequently seen on cultivated land. When compelled to seek safety in flight, it uses its wings to reach the nearest tree.

The Common Guinea Fowl, a well-known domestic species, is the descendant of the African Guinea Fowl, sometimes called the African Pheasant. The Domestic Turkey came originally from Northern Mexico, and is somewhat smaller than the wild bird, which still exists on the American continent.

The Mound-birds, or Brush Turkeys, of Australia deserve notice if only because of the lazy ingenuity with which they bury their eggs in decaying vegetable matter and then leave this natural incubator to hatch them out. The chicks develop their first set of feathers while still within their shells. When at last they cut their way out, they rest for a while in the mound, then wriggle to the top, not merely able to run but to fly!

It would be extremely interesting, were it possible, to obtain the actual story of the manner by which this practice has arisen. But however these birds may have arrived at the habit, it forms an interesting and instructive example of that mysterious power which in the lower orders of life we term "instinct."

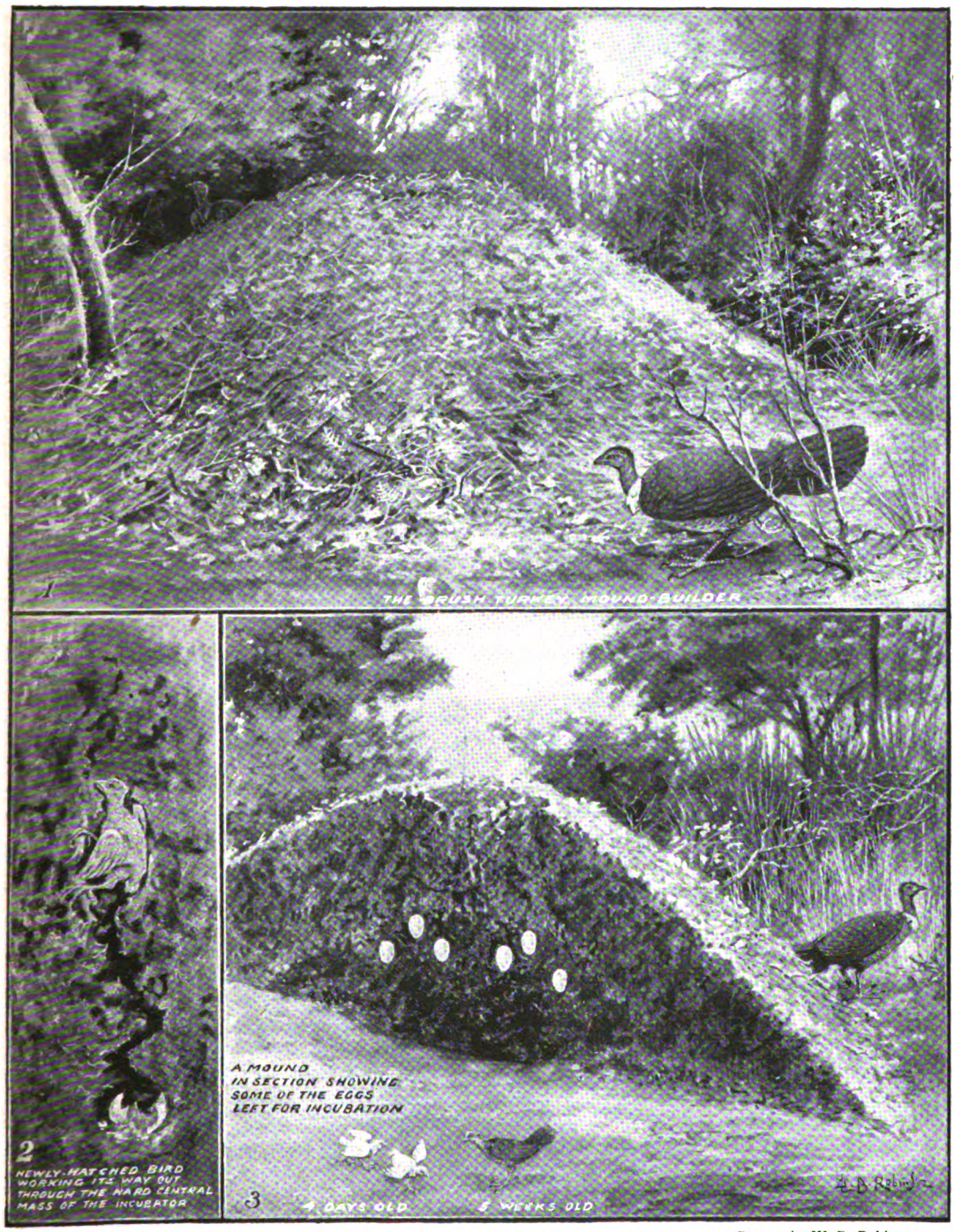
The Diurnal Birds of Prey were for long regarded by naturalists as representing the highest form of bird life. Even to-day general opinion, except amongst those who have made bird life something of a study, would place the swift, strong and remorseless Eagle at the very head of his class.

The Golden Eagle

But increasing knowledge has deposed him, and the once acknowledged King of the Birds with its rapacious companions now fills in the classified lists of the ornithologist a lower place than the small, timid and once despised Passeres or perching birds. None the less, the carnivorous birds, if only for their great size and strength, are of peculiar interest. Distributed practically all over the world, this order includes some five hundred different species. All alike, however, are marked by the pronounced bill, curved at the point, and formidable talons. Most of them feed entirely upon flesh.

The Golden Eagle, in fable and by tradition the King of Birds, and the largest of the European birds of prey, is found also in many parts of Asia. His plumage is mostly brown, though the head feathers have a golden tint that have given the bird his title. The fully grown Eagle seldom exceeds three feet in length; the wings, however, frequently measure nine feet from tip to tip, and this causes the bird when in the air to appear larger than it actually is. Birds and small mammals constitute the Eagle's chief food.

Opinions differ somewhat as to whether the Golden Eagle is as fearless as popular opinion depicts him. On the one hand we have tales of his extravagant daring, on the other stories of ignominious cowardice. It must be admitted, however, that those who depreciate his qualities overlook the fact that animals, other than human beings, are essentially practical. When hungry the Eagle exerts himself, at other times he shuns unnecessary labour. An Eagle with a full



Drawn by W. B. Robinson.

THE MOUND BIRDS OR BRUSH TURKEYS

with lazy ingenuity bury their eggs in decaying vegetable matter and leave this natural incubator to hatch them out. The chicks develop their first suit of feathers while still within their shells. When at last they cut their way out, they rest for a while in the mound, then wriggle to the top, not merely able to run, but to fly.

stomach is open to reason, an Eagle with an empty one is seldom disposed to admit that there is another side to the question. In neither case has pride any voice in his decision. It is one of the privileges of his condition that, being unaware of his reputation, he is at no pains to live up to it.

The Canadian Eagle is generally considered to be of the same species as the Golden Eagle.

Photo: F. Martin Duncan.

VULTURE,
of all birds the most repulsive in appearance and mode of living.

The Bald-headed Eagle of North America and Northern Europe has a white head and neck. It is this bird which is accepted as the national emblem of the United States.

The White-tailed Sea Eagle, a perceptibly smaller bird than the Golden Eagle, is common to Northern Europe and Asia, and may be found in certain spots in Great Britain. It subsists largely upon fish, though it does not disdain offal.

It is difficult to imagine any animal who, both in appearance and mode of living, is more repulsive than the Vulture. Hunched in the shoulders, horribly bald on the head and neck, there is something entirely disreputable in his appearance. How he contrives to find the carcass upon which he feeds is a question upon which opinion is still divided. The argument vision against scent, scent against vision, has still to produce an unanswerable case, on the one side as on the other. On the whole, opinion leans to the vision theory, though experiments with buried bodies would seem to show that his power of scent is at any rate not a negligible quantity. The American Vultures are mostly large birds with strong wings and hooked bills, though the latter are not sharp, as is the case with the more legitimate hunters. The talons, again, though prominent are blunted.

Condors and Ospreys

The Griffin Vulture, found in the South of Europe and in Africa and Asia, is about three feet in length. The Egyptian Vulture, a much smaller bird, has been known to reach Britain, though only in one or two isolated instances. His range extends from Southern Europe to India. In appearance he is far less repulsive than his American connections, his head and neck being covered with the same white plumage that mostly covers his body.

The Condor, the greatest of the American Vultures, vies with and even exceeds the Golden Eagle in size. Four feet in length and nine feet or more between the wing tips, this huge bird would be formidable in the extreme had it the same inclination to hunt live meat that it has to find carrion. Even as it is, however, it is not altogether a pleasant neighbour, since it occasionally carries off a lamb or a young goat. Condors are most powerful fliers, and in their strongholds in the Andes they nest always at a great elevation.

The Secretary-bird of South Africa, despite his length of limb, which occasionally gives him a height of over four feet, belongs to the same order as the Eagle and other birds of prey. The origin of his name is to be found in the peculiar crest of feathers, which resembles the ends of so many quill pens stuck behind the ear. The Secretary-bird is an omnivorous snake-eater, and as such does good service to the community in which he dwells.

The Osprey, which is widely scattered throughout the world and may still be seen in Scotland, is a fish eater.

The Gyr Falcon of northern latitudes displays the strong curved beak typical of his class. His plumage is white and black. The Peregrine Falcon, a smaller bird than the Gyr and a very rapid flier, may still be seen in the British Isles. The Mulin, one of the

smaller British Falcons, preys upon other and less formidable birds.

The Goshawk, now rare in Britain, was once extensively used in falconry. The Sparrowhawk, of brownish grey plumage, is very common in these islands. A small bird, not exceeding twelve inches in length, it is formidable by reason of its strength and assurance. There are many instances of Sparrowhawks having been tamed and trained to hunt other birds after the fashion of the Falcon proper.

The Kestrel feeds principally upon mice, lizards and beetles, but when food of this description is not obtainable it attacks and devours other birds.

The Red Kite of Europe and Northern Africa is seen in England to-day less frequently than was once the case. It is a formidable bird about two feet in length, and, when permitted to, makes itself responsible for considerable destruction in the poultry yard.

The Common Buzzard, once very numerous in Britain, is now confined to a few remote districts. He feeds principally upon mice, rats and insects.

Wading Birds

The wading birds, distinguished by their length of limb, may often be seen about our coasts, hunting in shallow water for the crustaceans, molluscs and worms upon which they feed. These birds are in many respects fortunately situated. To the ability to fly they add most generally strong running powers, facility in swimming, and in some instances the advantages to be derived from diving beneath the surface of the water. Most of these birds are migratory, and the majority change their plumage with the advent of cold weather.

The Plovers may be found in all parts of the world, though the tribe shows considerable variation in structure in different species. Most generally these birds haunt the marshes and sea shores, and they are consequently adapted in one respect or another to life in a swampy environment.

The Ringed Plover, so called from the white ring that separates his black head from his black back, is a small bird who may be found on the sea coast wherever large stretches of sand exist. The Golden Plover feeds upon molluscs and insects of all kinds. He is to be seen not only on the coast but also inland. The Golden Plover is a larger bird than the Ringed Plover with an attractive brown and gold coat.

The Lapwing, sometimes called the Peewit, is widely distributed throughout the British Isles, where he is a familiar sight upon marsh and meadow. The ingenious method by which this bird, when its young are threatened, lures the enemy from the nest by feigning lameness is well known.

The Oyster Catcher is a familiar figure upon the British coast, where he may be seen digging up molluscs, mussels and limpets

Photo: F. Martin Duncan.

GOLDEN EAGLE,

in fable and tradition the King of Birds, now fills in the classified lists of the ornithologist a lower place than the small, timid perching birds.

with his long yellow bill. Though a strong flier he is quite capable, when alarmed, of taking to the water, where his diving abilities stand him in good stead.

The Snipe, a native bird of mottled plumage, is common to many parts of Europe, Africa and Asia. Normally it frequents marsh lands. The Woodcock is considerably larger than the Snipe, and seldom remains in these islands during the summer months. It is essentially a marsh bird, and is most frequently seen at daybreak and after sunset. The Woodcock is a swift flier and by its dodging tactics affords the sportsman opportunity to exhibit his skill. A. B.

BOTANY.—II

4. Structure of a Seed.—Having illustrated the manner in which the student can, by simple observations, make his general knowledge of plants more accurate, we proceed to apply the same method to a more detailed study of *seeds*.

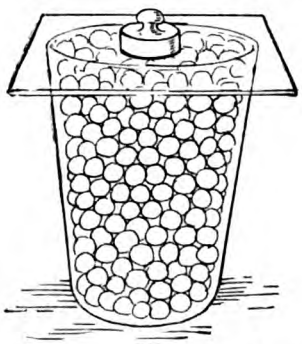


Fig. 7.—To demonstrate the absorption of water by seeds of the bean type.

A seed is essentially a young plant, or *embryo*, carefully protected against various enemies, and provided with a store of foodstuffs suitable for the embryo during the early stages of its development into an adult plant.

Morphologically, seeds may be classified under two types, well represented by the bean or pea, and the maize or wheat, respectively. In order to examine these seeds to advantage, they should be permitted to soak in water at least twenty-four hours before use. Procure a supply of these seeds from the seedsman ; soak a few of each well and examine them carefully.

DEMONSTRATION IV

The Bean Type.—Externally the seed of the bean shows a hard brown skin, the *testa*, and a long black scar, the *hilum*, where it was attached to the fruit. On soaking, the testa becomes soft and wrinkled, and can then be easily removed. Before removing the testa, however, notice that the whole seed swells greatly through the absorption of water.

This absorption of water is very considerable, as may be shown by weighing a dozen seeds before *and* after they have been soaked in water. The swelling may also be shown by filling a tumbler to the brim with peas and water, and covering the tumbler with a thin sheet of metal kept down by a small weight. As the peas absorb water, they swell and lift up the lid, in spite of the weight (Fig. 7). That the seed has absorbed water may be observed by drying a bean after it has been some hours in the water, and then pressing it between the fingers. At one place near the hilum a drop of water will be seen to exude ; in fact, a little hole can be noticed there—the only hole into the seed, known as the *micropyle* (Fig. 8).

On removing the testa, the rest of the seed is seen to fall into two white solid masses, called the *cotyledons*. If these two masses are carefully parted, however, they will be seen to be joined together at one place, as by a hinge. Here will be noticed a well-defined conical growth which is the *radicle*, or young root of the embryo ; and snugly pressed between the cotyledons is a small bud-like structure, which is the *plumule*, or embryo shoot. The embryo may thus be described as an axis consisting of a double cone, connected with the two cotyledons by short stalks ; at one end of the cone is the plumule, with the radicle at the other.

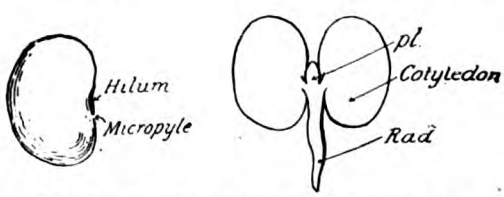


Fig. 8.—The broad bean, before and after the removal of the testa.

A plant like the bean, with two cotyledons, is called a *Dicotyledon*. But in the bean, the pea and many other dicotyledonous seeds, there is nothing else in the seed except the embryo. The necessary foodstuffs for the embryo are contained in the cotyledons. This, however, is not always the case, as may easily be seen by examining the seed

Fig. 9.—Spindle Tree. Sketch of a branch showing fruit.

of a privet or a spindle-tree. The seeds of the latter are enclosed in a conspicuous red cover, the fruit forming a conspicuous object in the hedgerows in autumn in many parts of England (Fig. 9). One of the seeds will be noticed, like the bean, to split easily in its two halves ; as it does so, however, a tiny green structure will slip out from between them. This is the embryo ; it consists

of two very thin, oval, green cotyledons, united at the base into a tapering radicle, and having a very tiny plumule between them (Fig. 10).

This seed thus resembles the bean in being a dicotyledon, but differs from it in having the food store outside the cotyledons.

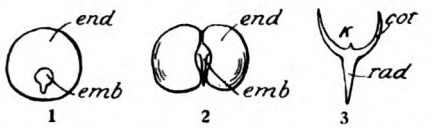


Fig. 10.—Seed of Spindle Tree (1) One half showing embryo lying on endosperm; (2) seed cut across longitudinally with embryo lying across two masses of endosperm; (3) embryo separated.

The food-store is then known as *endosperm*, and the seed is described as *endospermic* or (sometimes, but not so fitly) as *albuminous*. The bean is non-endospermic or ex-albuminous. The majority of dicotyledonous seeds are like the bean; but pansy, privet and castor-oil are like the spindle-tree. The embryo is, however, not always straight, as in these types: the cotyledons may be folded or coiled in various ways, as in Fig. 11; and the student should make diagrammatic sketches of as many seeds as he can examine, so as to show how the embryo is stored in the seed.

Coiled embryo
Fig. 11.

DEMONSTRATION V

The Maize Type.—Cut through a grain of Indian corn, which has been well steeped in water, with a clean sharp knife along its broadest axis. The cut surface will show the seed to consist of three noticeable parts. At the pointed end of the grain there is a greyish portion, sharply separated from the remainder, which is partly white and partly yellow. The greyish portion is the embryo; the rest is endosperm.

Examining the embryo more closely—a hand-lens is a useful aid for this purpose, and for many other purposes in botany—the radicle and plumule can be made out as two blunt cones at the opposite ends of an axis, while the rest of the embryo spreads out into a shield-like expansion firmly pressed against the endosperm. This is the single cotyledon, and the shield-like portion is often spoken of as the *scutellum*. With a fine needle, the radicle and plumule can be lifted away from the cotyledon, to which they are only connected by a short stalk. Moreover, it is possible also to show that the plumule is wrapped up in two or more leaves and that the radicle is protected by an enveloping sheath (Fig. 12).

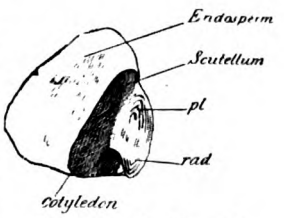
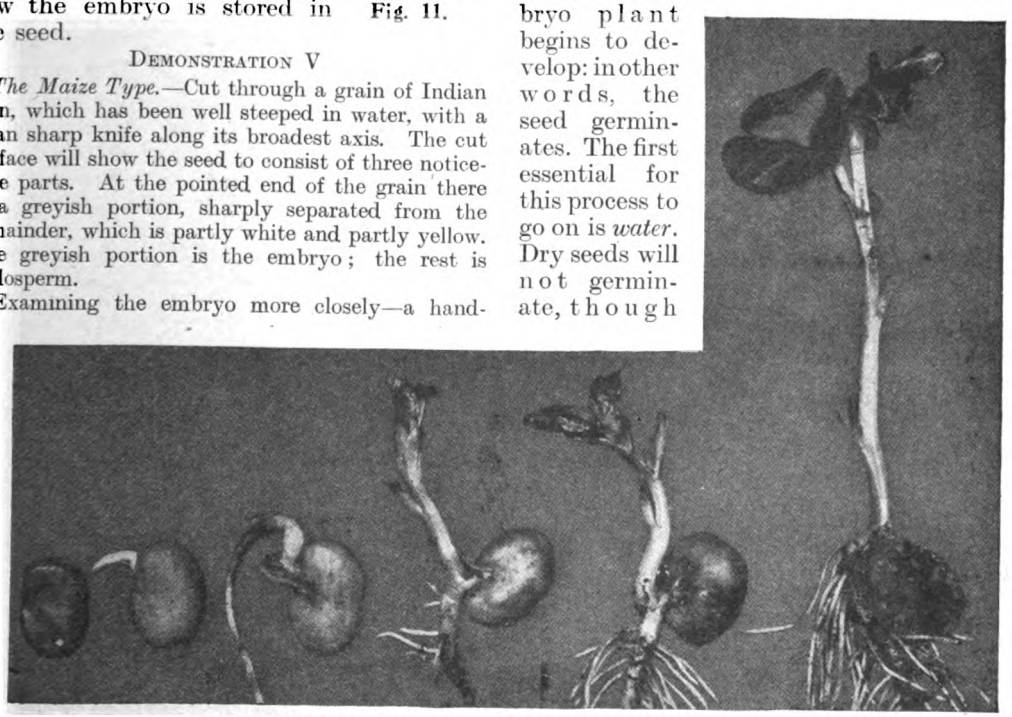


Fig. 12.—Section of Maize.

Plants like maize, wheat, lily, etc., whose seeds have only one cotyledon, are spoken of as *Monocotyledons*. There are plants, e.g. pines, which have more than two cotyledons; but the pines belong to a group known as *Gymnosperms* whose seeds are not enclosed in fruits and which do not produce flowers in the ordinary sense of the word. The flowering plants proper are spoken of as *Angiosperms*, i.e. plants with enclosed seeds; and all Angiosperms are either Dicotyledons or Monocotyledons.

5. Germination. — Under suitable conditions an embryo plant begins to develop: in other words, the seed germinates. The first essential for this process to go on is *water*. Dry seeds will not germinate, though



THE GERMINATION OF A BEAN.

the embryo in them will keep alive for years, even for centuries, as in the case of mummy-wheat. No less essential is a suitable temperature.

No seeds will develop at the freezing-point, though they may often be kept many degrees below it without injury. Seeds that have been soaked, however, die when cooled to the freezing-point. The most favourable temperature for germination differs for different plants; but the seeds of our outdoor plants grow best between about 65° F. and 90° F., though many of them will begin to grow at lower temperatures. Too high a temperature —from 110° F. to 120° F.—stops germination as surely as too low. For wheat, the minimum temperature for germination is 42° F., the maximum 108° F., and the optimum (or best) about 68° F.

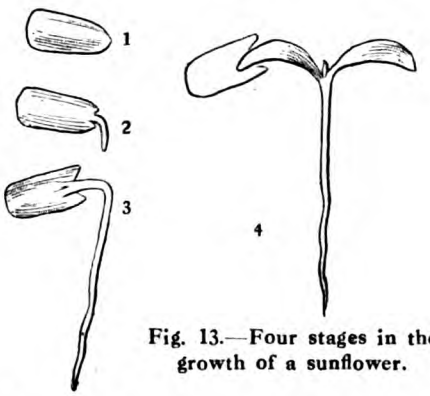


Fig. 13.—Four stages in the growth of a sunflower.

Fig. 14. Wheat.

Air is also necessary to germination, as the following experiment will show:

DEMONSTRATION VI

Enclose a few well-soaked peas in a well-corked bottle with a little water. Place the same number of peas in a similar but uncorked bottle. Notice the effect from day to day. It will soon become evident that the enclosed peas are not doing well. After a week remove the cork from the bottle, and lower a lighted taper into it. The taper will be extinguished. Add a little lime water, and shake up well: the lime water will turn milky, showing that carbonic acid gas has been produced.

From this experiment it is clear that the seeds use up the oxygen of the air, and produce carbonic acid gas, in the course of germination, consequently needing a supply of oxygen from the air.

The usual changes that accompany germination do not vary much in principle, although they do very much in detail. First the testa bursts, and the radicle begins to protrude. This is generally due to the elongation of the *hypocotyl*, as that portion of the axis immediately beneath the cotyledons is called; the radicle grows visibly in length from an early stage, and always turns on emerging from the seed so as to grow vertically downwards. Sometimes the cotyledons remain in the seed till the end of germination; but frequently they are drawn out by the elongating hypocotyl, and appear above ground as little green leafy structures.

They are not true leaves, which do not appear till later and come from the plumule; they are generally simpler in structure and shape, and drop off when the permanent leaves appear. The plumule does not usually develop till the radicle has made some sort of hold on the ground. Then it grows more rapidly, producing the stem and leaves of the mature plant. While all this takes place, the seed is shrinking in size, and its food store either altogether or partly disappears. It has of course been used for the food of the growing embryo.

DEMONSTRATION VII

These changes should be observed by the student in as many seeds as he can examine, and sketches should be made of various steps in the germination, as illustrated in Fig. 13. A selection from the following list would provide instructive observations: Bean, Pea, Acorn, Horse-chestnut, Sycamore, Sunflower, Cress, Vegetable Marrow, Wheat, Barley, Maize, Pine.

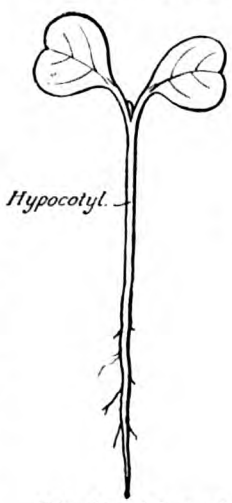


Fig. 15.—Mustard.

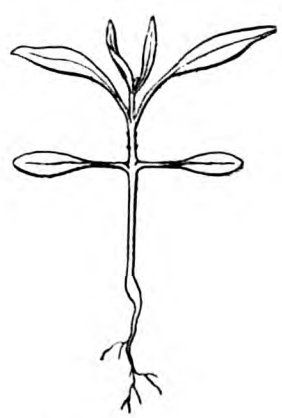


Fig. 16.—Wallflower.

Soak the seeds well, and place them on a piece of flannel kept damp in a saucer. Keep them in a warm place, and make daily records or sketches. For more special observations, it will be better to grow the seeds on moist sawdust in a wooden box which has had one of its sides taken out and replaced by glass. Such a germinator may be covered by an opaque or transparent lid, or left open (Fig. 17).

Divide the seeds experimented with into two

classes: (1) *hypogeal*—those whose cotyledons contain enough foodstuff for the young plant and do not emerge from the seed or become green; (2) *epigeal*—those whose cotyledons have to act as leaves, become green and rise above the ground.

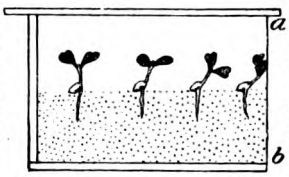


Fig. 17. — Germinating Box. Side *a b* is of glass. The box contains sawdust with half developed seeds on top.

The germinating box should be used to study the *effect of light* upon the seeds. If we arrange the box so that the light falls on the glass face, it will be noticed, in the case of all the seeds, that the plumule grows always towards the light, and the radicle away from it. If, however, the seeds are grown in a similar box without the glass face, it will be observed that even in darkness the plumule grows upward and the radicle downwards. The directing force in this case is gravitation, and this response to the action of gravity is called *geotropism*.

The directive action of light is called *heliotropism*. With a box illuminated from one side only, it can be observed that, where they are affected by both agents, the seeds make a compromise between the two. This

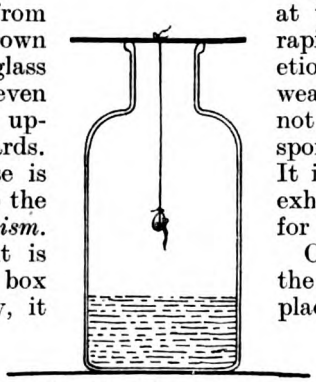
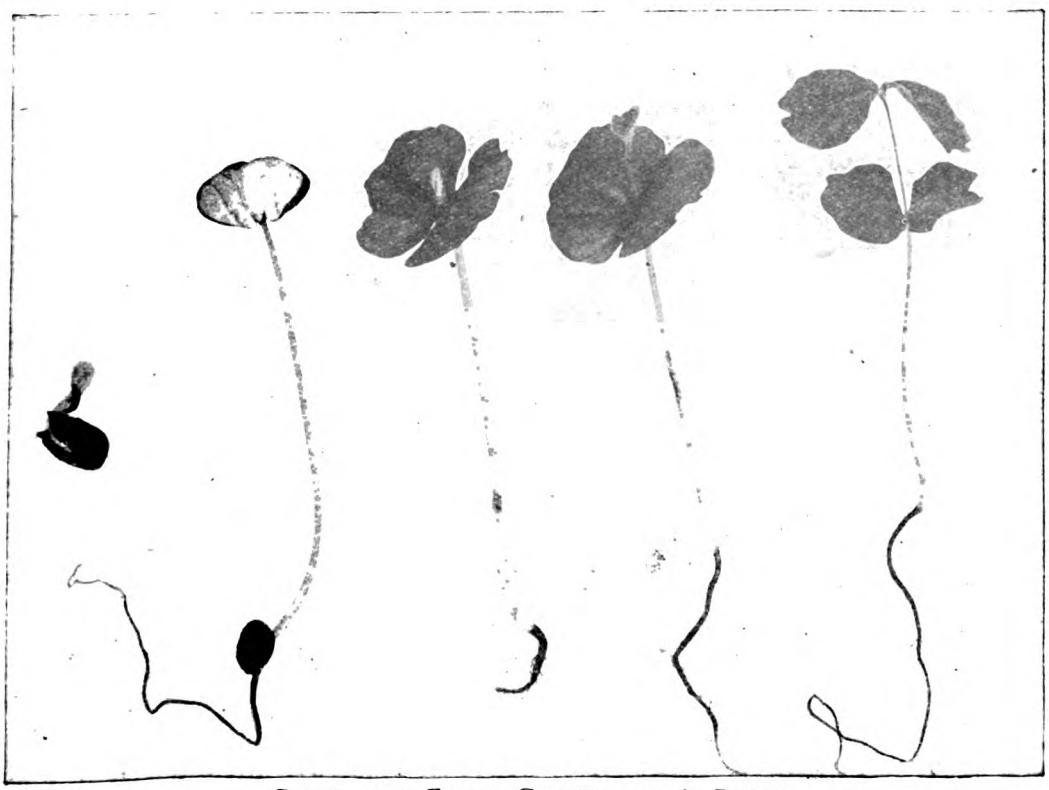


Fig. 18.—To show the directive action of light.

may also be well shown by supporting a seed on a hook in a bottle, as in Fig. 18. This also shows incidentally that germination can go on without either soil or its equivalent. Seedlings grown in the dark show one or two peculiar features which should be noted here, but which cannot be explained till later. The parts that should be green become yellowish and spotted (*etiolated*, as botanists call it); at the same time they grow more rapidly, but less strongly: an etiolated seedling is long, lanky and weak, its extra growth in length not being accompanied by a corresponding growth in general strength. It is as though the young plant exhausts itself in its vain struggle for light.

On the other hand, we find that if the early stages of germination take place in the light, instead of underground, the resulting plant is weakened. The young plumule is injured by premature exposure to light. E. W. E.



BIRTH AND EARLY GROWTH OF A BEECH.

Continued from page 165.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—XX

Gender (*Continued*).

(9) NOUNS of the third declension are feminine when they end in **-ās**, **-ăs**, **-ns**, in **-ĭs**, and **-ēs** not increasing in the genitive, and for the most part in **-s** preceded by a consonant (including the double consonant **x**). Among the exceptions are **ās**, *as* (the coin); **ĕlĕphās**, *elephant;* **gĭgās**, *giant;* **mās**, *male;* **vās**, **vădīs**, *surely*, masculine; **ădămās**, *diamond;* **fās**, **nĕfās** (both indeclinable); **vās**, **vāsĭs**, *vessel*, neuter; **fīnĭs**, *end;* **fūnĭs**, *rope;* **pānĭs**, *bread;* **piscĭs**, *fish*, etc., masculine; **călix**, *cup;* **fornix**, *arch;* **phœnix**, *phœnix;* **spādix**, *palm-branch;* **trādux**, *vine-branch*, masculine; **dens**, *tooth;* **fons**, *fount;* **mons**, *hill;* **ŏrĭens**, *east;* **torrens**, *torrent;* **trĭdens**, *trident*, masculine.

(10) Nouns of the third declension are neuter when they end in **-ă**, **ăr**, **-e**, **-ĕ**, **-ĭ**, **-l**, **-mĕn**, **-t**, **-ŭr**, or **-us**. Among the exceptions are **consŭl**, *consul;* **mūgĭl**, *mullet;* **pūgĭl**, *boxer;* **sāl**, *salt;* **sōl**, *sun;* **fūr**, *thief;* **furfŭr**, *bran;* **turtŭr**, *turtle-dove;* **vultŭr**, *vulture;* **lĕpŭs**, *hare;* **mūs**, *mouse*, masculine; **incūs**, *anvil;* **jŭventūs**, *youth;* **pălūs**, *swamp;* **sĕnectūs**, *old age;* **tellūs**, *the earth;* **virtūs**, *virtue;* and **pĕcŭs**, **-ŭdĭs**, *beast*, feminine (**pĕcŭs**, **pĕcŏrĭs**, *cattle*, is neuter).

(11) Nouns of the fourth declension are masculine if they end in **-us**, neuter if they end in **-u**. The following are exceptions: **ăcŭs**, *needle;* **dŏmŭs**, *house;* **īdūs** (plur.), *Ides;* **mănŭs**, *hand;* **nŭrŭs**, *daughter-in-law;* **pĕnŭs**, *food;* **portĭcŭs**, *portico;* **socrus**, *mother-in-law;* **trĭbŭs**, *tribe;* all feminine.

(12) The nouns of the fifth declension are all feminine, except **dĭēs**, *day*, which in the singular is either masculine (meaning an appointed day) or feminine (meaning time), and always masculine in the plural, and its compound **mĕrīdĭēs**, *midday*, which is masculine.

In dealing with the declension of nouns we came across several instances of irregularity, but we left the subject for a more methodical consideration at a more advanced stage.

Nouns Declined Irregularly

(1) First Declension. The genitive plural sometimes terminates in **-um** instead of **-arum**, especially in patronymics and other words of Greek origin and in nouns compounded with **-gĕnă**, and **-cŏlă**; thus **Dardănĭdum**, gen. of **Dardănĭdae**, *descendants of Dardanus;* **Grāiŭgĕnum**, gen. pl. of **Grāiŭgĕnă**, *Greek by birth;* **caelĭcŏlum**, gen. pl. of **caelĭcŏlă**, *dweller in heaven.* We also find **drachmum**, gen. pl. of **drachmă**, *a Greek coin;* and **amphŏrum**, gen. pl. of **amphŏră**, *jar.* The words **dĕă**, *goddess*, **fīlĭă**, *daughter*, and **lībertă**, *freed-woman*, have the dative and ablative plural **dĕābŭs**, **fīlĭabŭs**, **lībertabus**, to avoid confusion with **dĕīs**, **fīlĭīs**, dat. or abl. plur. of **dĕŭs**, **fīlĭŭs**, etc.

(2) Second Declension. There is a form of the genitive plural in **-um** instead of **-ōrum**. It is met with in nouns denoting weights and measures, as **nummum**, **tălentum**, **mĕdimnum**, gen. pl. of **nummŭs**, *coin;* **tălentum**, *talent;* **mĕdimnŭs** (**-um**), *a Greek bushel;* in numerals, as **dŭcentum**, **quăternum**, gen. of the adjectives **dŭcentī**, *two hundred;* **quăternī**, *four each;* in the names of peoples (in poetry) as **Teucrum**, gen. pl. of **Teucrī**, *Trojans*, and in some other nouns in poetry, as **dīvŭm**, gen. pl. of **dīvŭs**, *deity;* **vĭrum**, gen. pl. of **vĭr**, *man;* and **sŏcĭum**, gen. pl. of **sŏcĭŭs**, *ally.* The irregular declension of **dĕŭs**, *god*, is given in Vol. I., p. 99.

(3) Third Declension. The principal irregularities in the third declension are the accusative in **-im**, instead of **-em**, and the ablative in **-i**, instead of **-ĕ**. These forms appear only in **i**-stems. The nouns which have an accusative in **-im** are for the most part Greek names of places, as **Nĕāpŏlĭs**,

acc. **Nĕāpŏlim**; **Phălărĭs**, acc. **Phălărim**; names of animals and some other words derived from Greek, as **tīgrĭs**, acc. **tīgrim**, *tiger;* **bāsĭs**, acc. **bāsim**, *base, pedestal;* **ămussĭs**, *rule;* names of rivers, as **Tĭbĕrĭs**, acc. **Tĭbĕrĭm**, *Tiber;* **puppĭs**, *stern;* **rāvĭs**, *hoarseness;* **sĕcūrĭs**, *axe;* and the following: **sĭtĭs**, *thirst;* **turris**, *tower;* **tussĭs**, *cough;* and **vīs**; accusatives, **ămussim**, **puppim** (also **-em**), **rāvim**, **sĕcūrim** (also **-em**), **sĭtim**, **turrim** (also **-em**), **tussim**, **vim**.

Occasionally the accusative in **-em** occurs in other nouns, as in **febris**, *fever;* **messĭs**, *harvest;* **nāvĭs**, *ship;* **clāvĭs**, *key.*

The ablative in **-ī** almost invariably occurs with **sĕcūrĭs**, abl. **sĕcūrī**; **sĭtĭs**, abl. **sĭtī**; **tussĭs**, abl. **tussī**; **vīs**, abl. **vī**; and other words with accusative in **-im** only, and with **cănālĭs**, *canal*, abl. **cănālī**; **mărĕ**, *sea*, abl. **mărī** (or **mărĕ**); **sodālĭs**, *comrade*, abl. **sŏdālī**; and **strĭgĭlĭs**, *flesh-scraper*, abl. **strĭgĭlī**; and in adjectives ending in **-ĭs**, **-ĕ** and **-ĕr**, as **grăcĭlĭs**, *slender*, abl. **grăcĭlī**; **ācer**, *sharp*, abl. **ācrī**. In many other words **-ī** and **-ĭ** appear alternatively, as in **fĕbrĭs**, *fever;* **nāvĭs**, *ship;* **turrĭs**, *tower*, etc.

It should be noted that present participles in **-ens** when used as participles have the ablative in **-ĕ**; when they are used as adjectives this ablative is in **-ī**, thus: **-tē vĕnĭentĕ**, *on your arrival;* **cum ămantī mātrĕ vēnĭt**, *he came with his loving mother.*

Adjectives used as nouns have the ablative sometimes in **-ī**, sometimes in **-ĕ**; the following always have **-ī**: **annālĭs**, *annal;* **bipennĭs**, *two-headed axe;* **consŭlārĭs**, *a consular;* **fămĭlĭārĭs**, *friend;* **gentīlĭs**, *member of the same gens;* **nŏvālĭs**, *fallow;* **trĭbūlĭs**, *member of the same tribe.*

The rule for the genitive plural in this declension was that **i**-nouns, which are parisyllabic, take **-ĭum**, and consonant-nouns, which are imparisyllabic, take **-um**. This is a rule with many exceptions. Among the parisyllabic nouns taking **-um** instead of **-ĭum** are the following: **accĭpĭtĕr**, *hawk;* **ambāgēs**, *winding;* **cănĭs**, *dog;* **frātĕr**, *brother;* **iŭvĕnĭs**, *youth;* **mātĕr**, *mother;* **pătĕr**, *father;* **vātēs**, *bard;* **vŏlŭcrĭs**, *bird;* **ăpĭs**, *bee;* **mensis**, *month;* **sēdēs**, *seat*, may take either **-um** or **-ĭum**.

The following imparisyllabic nouns of one syllable with stems ending in single consonants take **-ĭum** instead of **-um**: **faux** (**faucĭum**), *throat;* **glīs** (**glīrĭum**), *dormouse;* **līs** (**lītĭum**), *lawsuit;* **mās** (**mărĭum**), *male;* **mūs** (**mūrĭum**), *mouse;* **nix** (**nĭvĭum**), *snow;* **strix** (**strĭgĭum**), *owl;* **vīs** (**vīrĭum**), *strength;* and usually **rēnes** (**rēnĭum**), *kidney.*

Nouns ending in **-ās**, gen. **-ātĭs**, take either **-um** or **-ĭum** in the gen. plur.; examples: **cīvĭtās** (**cīvĭtātĭum** or **-tum**), *state;* **optĭmātēs** (**optĭmātĭum** or **-tum**), *aristocrats;* **pĕnātēs** (**pĕnātĭum** or **-tum**), *household gods*, etc.

The following irregular nouns had better be declined in full:

Bōs (base, **bŏv-**), m. or f., *ox;* **sĕnex** (base, **sĕn-**), *old man.*

	Sing.	*Plur.*	*Sing.*	*Plur.*
N.V.	bōs	bŏvēs	sĕnex	sĕnēs
Acc.	bŏvem	bŏvēs	sĕnem	sĕnēs
Gen.	bŏvĭs	bŏvum	sĕnĭs	sĕnum
Dat.	bŏvī	būbŭs (*or* bōbŭs)	sĕnī	sĕnĭbŭs
Abl.	bŏvĕ	būbŭs (*or* bōbŭs)	sĕnĕ	sĕnĭbŭs

Iuppiter (**Iŏv-pătĕr** or **-pătĕr**), *Jupiter;* **Iūs iūrndum** (**iūsiūrandum**), n. *oath.*

Nom.	Iuppĭtĕr	iūs	iūrandum
Voc.	Iŏvĕ	iūs	iūrandum
Acc.	Iŏvem	iūs	iūrandum
Gen	Iŏvis	iūrĭs	iūrandī
Dat.	Iŏvī	iūrī	iūrandō
Abl.	Iŏvĕ	iūrĕ	iūrandō

Iūsiūrandum, which has no plural, is compounded of **iūs**, *obligation*, and **iūrandum**, gerund of **iūrō**, *swear.*

Exercise 19

Translate into English:

1. Parturiunt montes, nascetur ridiculus mus. 2. Cæsar inusitatum nostris oratoribus leporem quendam et salem est consecutus. 3. Quaque fuit tellus, illic et pontus et aër. 4. Quam vero aptas, quamque multarum artium ministras manus natura homini dedit. 5. Domus te nostra tota salutat. 6. Sicut unus paterfamilias his de rebus loquor.

Translate into Latin:

1. These things are not in our power (hand). 2. He came to Rome with a large gang (hand). 3. This is my home and fatherland. 4. Let the safety of the people be the supreme law. 5. Shall I, said he, go home or into the country? 6. Astyages killed the son of Harpagus with his own hand, and placed his cooked flesh before his father.

Key to Exercise 18

1. What country in the world is not full of our trouble? 2. Where justice is uncertain, there is no justice at all. 3. Out of two evils the less should be chosen. 4. A silent wound lives under her breast. 5. May some avenger arise out of our ashes. 6. So long as he is rich, even a barbarian pleases.

1. Barba tenus sapientes. 2. Consequitur quodcunque petit. 3. Pedibus timor addidit alas. 4. Aut insanit homo aut versus facit. 5. Aut inveniam viam aut faciam. E. A. B.

FRENCH.—XX

Irregular Verbs.—THERE are two classes of verbs which do not conform entirely with the normal conjugations set out in the foregoing lessons: (1) those that are defective or lacking in some of the moods, tenses, or persons of regular verbs, and (2) those that are simply irregular, having all these parts but departing more or less in form from the regular type. Most of the variations in form occur in the present indicative, which the student must learn with the utmost care. He should note that the difference between a regular and an irregular verb is not merely a difference of termination, but that the stem is modified. A point that has been emphasised in previous lessons, by printing the stems of the principal parts at the head of each conjugation, is that the stem is invariable in a regular verb. Knowing the stem, and being familiar with the system of endings, the learner can easily construct a paradigm of any regular verb in any given tense. When, on the other hand, the stem is variable, it is obviously necessary for each individual verb to be committed to memory. Since the irregular verbs are among those in most frequent use, their irregularities being in fact proofs of hard wear, the learner will have continual opportunities of testing his knowledge and refreshing his memory.

Irregular Verbs of the First Conjugation.—We have already dealt with the peculiarities of some verbs in both this and the fourth conjugation, not amounting in degree to what we are terming irregularity (*see* Lesson 14). Apart from these, there are only two verbs properly regarded as irregular in the first conjugation, viz. **aller**, *to go*, and **envoyer**, *to send*. These differ from the normal type in the parts indicated below.

ALLER, *to go*

Aller, allant, allé, je vais, j'allai.

Ind. Pres. : je vais, tu vas, il va,
nous allons, vous allez, ils vont.
Imperf. : j'allais, nous allions, etc.
Past Def. : j'allai, tu allas, il alla,
nous allâmes, vous allâtes, ils allèrent.
Fut. : j'irai, tu iras, il ira,
nous irons, vous irez, ils iront.
Cond. Pres. : j'irais, tu irais, il irait,
nous irions, vous iriez, ils iraient.
Imper. : va, allons, allez.
Subj. Pres. : que j'aille, ailles, aille.
que nous allions, alliez, aillent.
Imperf. : que j'allasse, allasses, allât.
que nous allassions, allassiez, allassent.

Note that **aller**, and also **s'en aller**, *to go away*, are conjugated in the compound tenses with the auxiliary **être**.

S'EN ALLER

Ind. Pres. : je m'en vais, tu t'en vas, il s'en va,
nous nous en allons, vous vous en allez,
ils s'en vont.
Imperf. : je m'en allais, nous nous en allions, etc.
Past Def. : je m'en allai, nous nous en allâmes,
Fut. : je m'en irai. [etc.
Cond. Pres. : je m'en irais, tu t'en irais, etc.
Subj. Pres. : que je m'en aille, etc.
Imperf. : que je m'en allasse, etc.

Perfect Indicative

je m'en suis allé, *I have gone away.*
tu t'en es allé, *thou hast gone away.*
il s'en est allé, *he has gone away.*
nous nous en sommes allés, *we have*, etc.
vous vous en êtes allés, *you have*, etc.
ils s'en sont allés, *they have*, etc.

Fut. Perf. : je m'en serai allé, *I shall have gone away.*
Cond. Perf. : je m'en serais allé, *I should have gone away.*
Pres. Subj. : que je m'en sois allé, etc.
Imperf. Subj. : que je m'en fusse allé.

ENVOYER, *to go*

Envoyer, envoyant, envoyé, j'envoie, j'envoyai.

Ind. Pres. : j'envoie, etc., envoyons, etc.
Fut. : j'enverrai, enverras, enverra, etc.
Cond. Pres. : j'enverrais, etc.

Irregular Verbs of the Second Conjugation.—There are a number of irregular verbs in the second conjugation, but these are mostly in the old conjugation which does not add **-iss-** to the stem in the present indicative, etc. (*see* Lesson 14). Let us take those belonging to the normal form of this conjugation first.

BÉNIR, *to bless*

Past Part. : béni, bénie: bénit, bénite: *consecrated, blessed*, as in—

Un enfant, béni par son père, *A child blessed by its father.*
Une âme bénie, *A blessed soul.*
Pain bénit, eau bénite, *Holy bread, consecrated water.*

Note that this verb is irregular only in the past participle, **béni**, meaning *blessed* by man or God, **bénit**, *consecrated* by the priest.

FLEURIR, *to flourish*

Pres. : fleurissais, etc.
Older form, florissais, etc.
Pres. Part. : fleurissant, -ante. florissant, -ante.

The latter are relics of an old verb **florir**.

HAÏR, *to hate*

Haïr, haïssant, haï, je hais, je haïs.

Pres. : je hais, tu hais, il hait
nous haïssons, etc.
Fut. : je haïrai, etc.
Imper. : hais, haïssons, haïssez.
Subj. Pres. : que je haïsse, etc.

Observe that the only irregularity here is the dropping of the diæresis in the present indicative singular and the second person singular imperative.

Miscellaneous Idioms.—Est-ce que.—With a few exceptions, the ordinary interrogative construction is not allowed in the first person singular present indicative of verbs having in that form but one syllable. In questions, the expression **est-ce que** is prefixed to the affirmative form, thus—

Est-ce que je vends du drap ?	*Do I sell cloth ?*
Est-ce que je joue souvent ?	*Do I play often ?*

The following verbs, however, follow the ordinary rule :—

aller, *to go.*	être, *to be.*
avoir, *to have.*	pouvoir, *to be able.*
devoir, *to owe.*	savoir, *to know.*

Examples :

Ai-je vos mouchoirs ?	*Have I your handkerchiefs ?*
Combien vous dois-je ?	*How much do I owe you ?*

The form **est-ce que** may also be used when the first person singular indicative has more than one syllable, as in—

Est-ce que je vous envoie des livres ?	*Do I send you books ?*
Est-ce que je commence à parler ?	*Do I begin to speak ?*

It may also be used colloquially with any person of the tenses that are conjugated interrogatively. Thus, *What do you read ?* may be rendered by **qu'est-ce que vous lisez ?** as well as by **que lisez-vous ?**

Aller, Venir, etc., with the Infinitive.—The verb **aller** is used with the infinitive exactly in the same way as *to go* in English, to indicate a proximate future. Compare this with the parallel use of the verb **devoir** (Lesson 19).

Examples :

Je vais parler à monsieur votre père,	*I am going to speak to your father.*
Allez-vous écrire ce matin ?	*Are you going to write this morning ?*
J'allais parler de lui,	*I was going to speak of him.*

The verb **venir** is used with the infinitive preceded by the preposition **de** to indicate a past just elapsed, thus—

Je viens d'écrire mes lettres,	*I have just written my letters.*
Nous venons de recevoir des nouvelles,	*We have just heard news.*

Aller trouver and **venir trouver** are used in the sense *to go to, to come to,* with substantives denoting persons, as in—

Allez trouver le ferblantier,	*Go to the tinman.*
J'ai envie d'aller le trouver,	*I have a mind to go to him.*
Venez me trouver à dix heures.	*Come to me at ten o'clock.*

Aller chercher, means *to go for, to go and fetch,* **envoyer chercher,** *to send for, to send and fetch,* as in—

Allez chercher le médecin,	*Go and fetch the doctor.*
Je vais chercher du sucre et du café,	*I am going for coffee and sugar.*
Envoyez chercher le marchand,	*Send for the merchant.*
J'envoie chercher des légumes,	*I am sending for vegetables.*

VOCABULARY

affaiblir, *to weaken.*	l'église (f.), *the church.*
le berceau, *the cradle.*	malade, *ill.*
la campagne, *the country.*	l'origine (f.), *the origin.*
causer, *to chat.*	par ici, *here.*
une connaissance, *an acquaintance.*	le récit, *the story.*
couper, *to cut.*	regarder, *to look at.*
déchirer, *to tear.*	le risque, *the risk.*

Exercise 37

1. Vous n'avez jamais entendu parler de la comtesse de G ? 2. Vous devez en savoir quelque chose. 3. Vous allez me dire tout ce que vous savez de la chose. 4. Venez par ici. Nous allons causer. 5. Ah ! il ne faut pas regarder aux origines, pas plus pour les femmes que pour les nations. 6. Il ne faut pas regarder au berceau de personne. 7. Elle peut s'en aller. 8. Mais pourrai-je rappeler, sans l'affaiblir, ce récit ? 9. Avant de partir pour l'autre monde, je veux faire à tout risque mon porte-manteau. 10. Quand je suis malade, je l'envoie chercher. 11. Nous venons de recevoir de l'argent. 12. Je viens de déchirer mon habit. 13. Votre frère va-t-il trouver son ami ? 14. Allez-vous chercher de l'argent. 15. J'ai l'intention d'y aller mardi. 16. N'allez-vous pas écrire à vos connaissances ? 17. On se trompe souvent soi-même en cherchant à tromper les autres. 18. Je m'ennuie à la ville et je m'amuse à la campagne. 19. À quoi vous amusez-vous ? 20. Nous nous promenons le matin, et nous travaillons le reste de la journée.

Exercise 38

1. What have you just done ? 2. Is your brother going to his friend ? 3. He goes to him every day. 4. Do you go to that lady's house on Monday ? 5. I intend to go there on Tuesday. 6. He goes to church on Sundays. 7. What are you going to do ? 8. I am going to do my lessons. 9. I am not going to write to any one. 10. Do you not intend to come to me to-morrow ? 11. Does your companion go to church every Sunday ? 12. Saturdays I stay at home. Sundays I go to church. 13. I amuse myself in reading German. 14. Are you often tired of the country ? 15. Is there any news of monsieur D ? 16. Nothing has been heard of him. 17. Are you not mistaken sometimes ? 18. Everybody makes mistakes sometimes. 19. I am bored when I have nothing to do. 20. I do not use it, it does not cut.

E. A. B.

GERMAN.—XVII

Verbs—*Continued*

STRONG AND IRREGULAR WEAK VERBS—*Continued*

1	2	3	4	5	6	7
Rinnen(25), *run, flow*	—	rann	ränne	—	geronnen	1b
Rufen, *call*	—	rief	riefe	—	gerufen	2d
Saufen, *swill*	ſäufſt, ſäuft	ſoff	ſöffe	—	geſoffen	3d
Saugen, *suck*	—	ſog	ſöge	—	geſogen	3d
Schaffen(26), *create*	—	ſchuf	ſchüfe	—	geſchaffen	2b
Schallen, *sound*	—	ſcholl	ſchölle	—	geſchollen	3e
Scheiden, *separate*	—	ſchied	ſchiede	—	geſchieden	3b
Scheinen, *shine, appear*	—	ſchien	ſchiene	—	geſchienen	3b
Schelten(27), *scold*	ſchiltſt, ſchilt	ſchalt	ſchälte	ſchilt	geſcholten	1c
Scheren, *shear*	ſchierſt, ſchiert	ſchor	ſchöre	ſchier	geſchoren	3e
Schieben, *shove*	—	ſchob	ſchöbe	—	geſchoben	3c
Schießen, *shoot*	—	ſchoß	ſchöſſe	—	geſchoſſen	3c
Schinden, *flay*	—	ſchund	ſchünde	—	geſchunden	3f
Schlafen, *sleep*	ſchläfſt, ſchläft	ſchlief	ſchliefe	—	geſchlafen	2c
Schlagen, *strike*	ſchlägſt, ſchlägt	ſchlug	ſchlüge	—	geſchlagen	2b
Schleichen, *sneak*	—	ſchlich	ſchliche	—	geſchlichen	3a
Schleifen, *whet*	—	ſchliff	ſchliffe	—	geſchliffen	3a
Schleißen, *slit*	—	ſchliß	ſchliſſe	—	geſchliſſen	3a
Schließen, *shut*	—	ſchloß	ſchlöſſe	—	geſchloſſen	3c
Schlingen, *sling*	—	ſchlang	ſchlänge	—	geſchlungen	1a
Schmeißen, *fling*	—	ſchmiß	ſchmiſſe	—	geſchmiſſen	3a
Schmelzen, *melt*	ſchmilzeſt, ſchmilzt	ſchmolz	ſchmölze	ſchmilz	geſchmolzen	3e
Schnauben, *snort*	—	ſchnob	ſchnöbe	—	geſchnoben	3d
Schneiden, *cut*	—	ſchnitt	ſchnitte	—	geſchnitten	3a
Schrauben, *screw*	—	ſchrob	ſchröbe	—	geſchroben	3d
Schreiben, *write*	—	ſchrieb	ſchriebe	—	geſchrieben	3b
Schreien, *cry*	—	ſchrie	ſchriee	—	geſchrien	3b
Schrecken(28), *be afraid*	ſchrickſt, ſchrickt	ſchrak	ſchräke	ſchrick	geſchrocken	1c
Schreiten, *stride*	—	ſchritt	ſchritte	—	geſchritten	3a
Schwären(29), *suppurate*	ſchwierſt, ſchwiert	ſchwor	ſchwöre	—	geſchworen	3e
Schweigen, *be silent*	—	ſchwieg	ſchwiege	—	geſchwiegen	3b
Schwellen, *swell*	ſchwillſt, ſchwillt	ſchwoll	ſchwölle	ſchwill	geſchwollen	3e
Schwimmen(30), *swim*	—	ſchwamm	ſchwämme	—	geſchwommen	1b
Schwinden(31), *vanish*	—	ſchwand	ſchwände	—	geſchwunden	1a
Schwingen(32), *swing*	—	ſchwang	ſchwänge	—	geſchwungen	1a
Schwören(33), *swear*	—	ſchwor	ſchwöre	—	geſchworen	3e
Sehen, *see*	ſiehſt, ſieht	ſah	ſähe	ſieh	geſehen	2a
Sein, *be*	bin, biſt, iſt	war	wäre	ſei	geweſen	
Senden(34), *send*	—	ſandte	ſendete	—	geſandt	
Sieden(35), *boil*	—	ſott	ſiedete	—	geſotten	3c
Singen, *sing*	—	ſang	ſänge	—	geſungen	1a
Sinken, *sink*	—	ſank	ſänke	—	geſunken	1a
Sinnen(36), *meditate*	—	ſann	ſänne	—	geſonnen	1b
Sitzen, *sit*	—	ſaß	ſäße	—	geſeſſen	1d
Sollen, *shall*	ſoll, ſollſt, ſoll	ſollte	ſollte	wanting	geſollt	

(25) Past Conj.; also rönne. (26) Usually weak in the sense of *to procure*. (27) Past Conj.; also ſchölte. (28) Weak in transitive sense *to frighten;* most common in compound form erſchrecken. (29) Often weak. (30) Pret. Ind. and Past Conj.; also ſchwomm, ſchwömme. (31) Past Pret. Ind. and Past Conj.; also ſchwund, ſchwünde. (32) Pret. Ind. and Past Conj.; also ſchwung, ſchwünge. (33) Pret. Ind. and Past Conj.; also ſchwur, ſchwüre. (34) Pret. Ind.; also ſendete. (35) Mostly weak. (36) Past Conj.; also ſönne.

Verbs—Continued

STRONG AND IRREGULAR WEAK VERBS—*Continued*

1	2	3	4	5	6	7
Speien, *spit*	—	ſpie	ſpie(e)	—	geſpien	3b
Spinnen(37), *spin*	—	ſpann	ſpönne	—	geſponnen	1b
Sprechen, *speak*	ſprichſt, ſpricht	ſprach	ſpräche	ſprich	geſprochen	1c
Sprießen, *sprout*	—	ſproß	ſpröſſe	—	geſproſſen	3c
Springen, *spring*	—	ſprang	ſpränge	—	geſprungen	1a
Stechen, *prick*	ſtichſt, ſticht	ſtach	ſtäche	ſtich	geſtochen	1c
Stecken(38), *stick*	ſtickſt, ſtickt	ſtak	ſtäke	ſtick	geſteckt	1c
Stehen(39), *stand*	—	ſtand	ſtände	—	geſtanden	3b
Stehlen, *steal*	ſtiehlſt, ſtiehlt	ſtahl	ſtähle	ſtiehl	geſtohlen	1c
Steigen, *mount*	—	ſtieg	ſtiege	—	geſtiegen	3b
Sterben(40), *die*	ſtirbſt, ſtirbt	ſtarb	ſtürbe	ſtirb	geſtorben	1c
Stieben, *disperse*	—	ſtob	ſtöbe	—	geſtoben	3c
Stinken(41), *stink*	—	ſtank	ſtänke	—	geſtunken	1a
Stoßen, *push*	ſtößt, ſtößt	ſtieß	ſtieße	—	geſtoßen	2d
Streichen, *stroke*	—	ſtrich	ſtriche	—	geſtrichen	3a
Streiten, *contend*	—	ſtritt	ſtritte	—	geſtritten	3a
Tun, *do*	—	tat	täte	—	getan	
Tragen, *carry*	trägſt, trägt	trug	trüge	—	getragen	2b
Treffen, *hit*	triffſt, trifft	traf	träfe	triff	getroffen	1c
Treiben, *drive*	—	trieb	triebe	—	getrieben	3b
Treten, *tread*	trittſt, tritt	trat	träte	tritt	getreten	2a
Triefen(42), *drip*	—	troff	tröffe	—	getroffen	3c
Trinken(43), *drink*	—	trank	tränke	—	getrunken	1a
Trügen, *deceive*	—	trog	tröge	—	getrogen	3c
Verderben(44), *spoil*	verdirbſt, verdirbt	verdarb	verdürbe	verdirb	verdorben	1c
Verdrießen, *vex*	—	verdroß	verdröſſe	—	verdroſſen	3c
Vergeſſen, *forget*	vergiſſeſt, vergißt	vergaß	vergäße	vergiß	vergeſſen	2a
Verlieren, *lose*	—	verlor	verlöre	—	verloren	3c
Wachſen, *grow*	wächſt, wächſt	wuchs	wüchſe	—	gewachſen	2b
Wägen(45), *weigh*	—	wog	wöge	—	gewogen	3e
Waſchen, *wash*	wäſcheſt, wäſcht	wuſch	wüſche	—	gewaſchen	2b
Weben(46), *weave*	—	wob	wöbe	—	gewoben	3e
Weichen, *yield*	—	wich	wiche	—	gewichen	3a
Weiſen, *show*	—	wies	wieſe	—	gewieſen	3b
Wenden(47), *turn*	—	wandte	wendete	—	gewandt	
Werben(48), *sue*	wirbſt, wirbt	warb	würbe	wirb	geworben	1c
Werden, *become*	wirſt, wird	ward / wurde	würde	—	geworden	1c
Werfen, *throw*	wirfſt, wirft	warf	würfe	wirf	geworfen	1c
Wiegen(49), *weigh*	—	wog	wöge	—	gewogen	3c
Winden, *wind*	—	wand	wände	—	gewunden	1a
Wiſſen, *know*	weiß, weißt, weiß	wußte	wüßte	wiſſe	gewußt	
Wollen, *wish*	will, willſt, will	wollte	wollte	—	gewollt	
Zeihen, *accuse*	—	zieh	ziehe	—	geziehen	3b
Ziehen, *draw*	—	zog	zöge	—	gezogen	3c
Zwingen, *compel*	—	zwang	zwänge	—	gezwungen	1a

(37) Past Conj.; also ſpönne. (38) Strong as a transitive verb, otherwise weak. (39) Pret. Ind. and Past Conj.; also ſtund, ſtünde. (40) Past Conj.; rarely ſtärbe. (41) Pret. Ind. and Past Conj.; also ſtunk, ſtünke. (42) Often weak. (43) Pret. Ind. and Past Conj.; also trunk, trünke. (44) Often weak in the transitive sense. (45) Another form of wiegen, *see* below. (46) Mostly weak. (47) Pret. Ind. and Past Part.; also wendete, gewendet. (48) Past Conj.; rarely wärbe. (49) wiegen, *to rock*, is weak.

VOCABULARY

Handſchuh, s.m.2, *glove.*
Kampfſpiel, s.n.2, *combate* (for a prize).
ſitzen, s., *to sit.*
rings, *around* (adv.).
Dame, w.f., *lady.*
Winken, w., *to beckon make a sign.*
auftun (ſich), s., *to open* (intrans.).
Zwinger, s.m.1, *den.*
Schritt, s.m.2, *step, tread.*
umſehen (ſich), s., *to look round.*
ſtumm, *dumb.*
ſchütteln, w., *to shake.*
ſtrecken, w., *to stretch.*
niederlegen (ſich), *to lie down.*
behend, *quickly, swiftly.*
rennen, *to run.*
Sprung, s.m.2, *leap.*
Wie, *when, as soon as.*
brüllen, w., *to roar.*
Schweif, s.m.2, *tail.*
Reif, s.m.2, *hoop, ring.*
recken, w., *to stretch.*
Kreis, s.m.2, *circle.*
umgehen, *to go round.*
knurren, w., *to growl.*
Seite, w.f., *side.*
doppelt, *doubly.*
auf einmal, *at one and the same time.*
mutig, *courageous.*
Begier, w.f., *desire, lust.*
Tatze, w.f., *claw.*
aufrichten (ſich), w., *to arise.*
Mord, s.m.2, *murder.*
lagern (ſich), w., *to lie down.*
Katze, w.f., *cat.*
Altan, s.m.2, *balcony, gallery.*
Hand, s.f.2, *hand.*
Ritter, s.m.1, *knight.*
Weiſe, w.f., *manner.*
ei, *why* (exclamation).
aufheben, s., *to pick up.*
Lauf, s.m.2, *run, course.*
Ungeheuer, s.m.1, *monster.*
nehmen, s., *to take.*
Erſtaunen, s.n.1, *astonishment.*
Edelfrau, w.f., *noble ladies.*
zurückbringen, *to bring back.*
Lob, s.n., *praise.*
zärtlich, *tender.*
verheißen, s., *to promise, announce.*
Glück, s.n., *happiness.*
begehren, w., *to desire.*
ſelb, *same, selfsame.*
Löwe, w.m., *lion.*
erwarten, w., *to await.*
um, *round* (prep.).
Balkon, s.m. (plur. Balkons), *balcony.*
Kranz, s.m.2, *wreath, circle, garland.*
Finger, s.m.1, *finger.*
weit, *wide, spacious.*
bedächtig, *slow, measured.*
treten, s., *to tread, step.*
Gähnen, s.n.1, *yawn.*
Mähne, w.f., *mane.*
Glied, s.n.3, *limb.*
wieder, *again.*
Tor, s.n.2, *gate, door.*
wild, *wild.*
Tiger, s.m.1, *tiger.*
erſchauen, w., *to espy.*
laut, *loud.*
einen Reif ſchlagen, *to form a hoop.*
furchtbar, *terrible.*
Zunge, w.f., *tongue.*
ſcheu, *shy, nervous.*
grimmig, *wrathful, awful.*
murren, w., *to grumble.*
ſpeien, s., *to vomit, spit.*
Leopard, w.m., *leopard.*
ſtürzen, w., *to rush, fling oneself.*
Kampf, s.m.2, *combat, battle.*
packen, w., *to seize.*
Gebrüll, s.n., *roar.*
ſtill, *quiet, silent.*
Sucht, w.f., *eager desire.*
gräulich, *horrible.*
fallen, s., *to fall.*
Rand, s.m.3, *edge.*
mitten hinein, *into the midst.*
ſpotten, w., *to mock.*
ſchwören, s., *to swear, vow.*
ſo, *then.*
ſchnell, *quick, speedy.*
hinabſteigen, s., *to climb down, descend.*
Mitte, w.f., *middle, midst.*
keck, *bold.*
Grauen, s.n.1, *horror.*
gelaſſen, *cool.*
ſchallen, w., *to resound.*
Mund, s.m.2, *mouth.*
Liebesblick, s.m.2, *look of love.*
nah, *near.*
empfangen, s., *to receive.*
werfen, s., *to throw.*
Dank, s.m., *thanks.*
Geſicht, s.n.3, *face.*
verlaſſen, s., *to leave, desert.*

Exercise 41

Der Handſchuh.[1]

Vor ſeinem Löwengarten,[2]
Das Kampfſpiel zu erwarten,
Saß König Franz,
Und um ihn die Großen[3] der Krone,
Und rings auf hohem Balkone,
Die Damen in ſchönem Kranz.

Und wie er winkt mit dem Finger,
Auf[4] tut ſich der weite Zwinger,
Und herein mit bedächtigem Schritt
Ein Löwe tritt,
Und ſieht ſich ſtumm
Rings um
Mit langem Gähnen,
Und ſchüttelt die Mähnen[5]
Und ſtreckt die Glieder,
Und legt ſich nieder.

Und der König winkt wieder;
Da öffnet ſich behend
Ein zweites Tor,
Daraus rennt
Mit wildem Sprunge
Ein Tiger hervor.
Wie der[6] den Löwen erſchaut,
Brüllt er laut,
Schlägt mit dem Schweif
Einen furchtbaren Reif
Und recket[7] die Zunge,
Und im Kreiſe ſcheu
Umgeht er den Leu[8]
Grimmig ſchnurrend,
D'rauf[9] ſtreckt er ſich murrend
Zur Seite nieder.

Und der König winkt wieder;
Da ſpeit das doppelt geöffnete Haus
Zwei Leoparden auf einmal aus,
Die ſtürzen mit mutiger Kampfbegier
Auf das Tigertier[10];
Das packt ſie mit ſeinen grimmigen Tatzen,
Und der Leu mit Gebrüll
Richtet ſich auf, da wird's[11] ſtill;
Und herum im Kreis,
Von Mordſucht heiß,
Lagern ſich die gräulichen Katzen.[12]
Da fällt von des Altans Rand
Ein Handſchuh von ſchöner Hand,
Zwiſchen den Tiger und den Leu'n[13]
Mitten hinein.

Und zu Ritter Delorges, ſpottender Weiſ',[14]
Wendet ſich Fräulein Kunigund:
„Herr Ritter, iſt eure[15] Lieb ſo heiß,
Wie ihr mir's ſchwört zu jeder Stund',[16]
Ei, ſo hebt mir[17] den Handſchuh auf!"

Und der Ritter, in ſchnellem Lauf,
Steigt hinab in den furchtbar'n Zwinger
Mit feſtem Schritte,
Und aus der Ungeheuer[18] Mitte
Nimmt er den Handſchuh mit keckem Finger.

Und mit Erſtaunen und mit Grauen
Sehen's die Ritter und Edelfrauen,
Und gelaſſen bringt er den Handſchuh zurück,
Da ſchallt ihm ſein Lob aus jedem Munde,
Aber mit zärtlichem Liebesblick—
Er[19] verheißt ihm ſein nahes Glück—
Empfängt ihn Fräulein Kunigunde.
Und er wirft ihr den Handſchuh ins Geſicht:
„Den Dank, Dame, begehr' ich nicht."
Und verläßt ſie zu ſelben Stunde.

Friedrich V. Schiller.

NOTES:—

(1) Handſchuh is literally *hand shoe.* (2) Löwengarten, a similar compound to *Zoological Garden.* (3) großen der Krone, *the great ones*

of the crown, i.e. the high court officials and dignitaries. (4) In prose the order would be wie er mit dem Finger winkt tut ſich der weite Zwinger auf. (5) Ordinarily singular, die Mähne. (6) der is a demonstrative pronoun here. (7) recket the fuller form, instead of reckt on account of the metre. (8) Leu—poetical for Löwe. (9) drauf, contracted from darauf, *thereupon*. (10) Tigertier, literally, *tiger animal*, a very common form of compound in German, which is best rendered by the simple word *tiger*. (11) wird's = wird es. (12) Katzen, as they all belong to the cat family. (13) Leun—contracted from Leuen. (14) ſpottender Weiſe, a genitive used adverbially, in a mocking way. (15) eure, the plural, 2nd person, was a common form of polite address in olden times before the 3rd person Sie took its place. (16) Stunde, used in the sense of *a moment* of time. (17) mir, ethic dative. (18) Ungeheuer gen. plur. depending on Mitte. (19) er refers to Liebesblick. Rhymes such as Blick and Glück, Gebrüll and ſtill are common in all German verse.

VOCABULARY

soon, bald.
find out, herausfinden, s. (sep.).
queen, Königin, w.f.
go into, in, hineingehen (sep.).
take off, abnehmen (sep.) von.
bed, Bett, s.n. (weak plur.)
bar, Latte, w.f.
eiderdown bed, Federbett.
morning, Morgen, s.m.l.
sleep, ſchlafen, s.
badly, ſchlecht.
only, allein.
lie, liegen, s.
black and blue, braun (*brown*) und blau.
make, machen, w.
frightful, furchtbar.
evident, klar.
through, durch.
place, Stellen, w.
true, wahr.
think, denken (mixed).
nothing, nichts.
bedroom, Schlafzimmer, s.n.l.
thing, Sache, w.f.
lay, legen, w.
mattress, Matratze, w.f.
should, ſollte.
ask, fragen, w.
awfully, ſchrecklich.
hardly, kaum.
know, wiſſen, s.
hard, hart.
all over, am ganzen Körper (*over the whole body*).
now, nun.
thin skinned, empfindlich.
take away, fortnehmen (sep.).
story, Geſchichte, w.f.

Exercise 42

THE PRINCESS AND THE PEA (*continued*)

"Oh! we will soon find out!"[1] thought the old queen; but she said nothing, went into the bedroom, took all the things off the bed, and laid a pea on[2] one of the bars. Then she laid twenty mattresses on the pea and twenty eiderdown beds upon the mattresses. There the princess should sleep for[3] that night.

In the morning[4] they asked her how she had[5] slept.

"Oh! awfully badly!" she said. "I have hardly had a wink all the night.[6] Heaven[7] only knows what there was in the bed! I have been[8] lying on something hard,[9] which has made me black and blue all over. It is something frightful."

It[10] was evident now that she was[11] a real princess, since she had felt the pea through twenty mattresses and twenty eiderdown beds. Only a real princess could[12] be so thin skinned.

So the prince married her, for he knew that here was[11] a real princess; and the pea was placed in[13] a museum, where it[14] may still be seen if somebody[15] has not taken it away.

Now this is[16] a true story.

NOTES:—

(1) Say, find that out. (2) What case does auf govern here, and why? (3) Omit *for* in translating. (4) In the morning—use the gen. with the def. art. and without any prep. (5) Had, conjunctive. (6) I have hardly . . . night, ich habe die ganze Nacht kaum ein Auge zugetan (I have hardly closed an eye). (7) Say, the heaven. (8) Have been lying—take care not to translate the progressive form by the verb to be. Use the simple perfect, I have lain. (9) Hard, following etwas must be in the dative, governed by auf. (10) It was now evident. (11) Was, present or past conjunctive. (12) Could, use the past conjunctive könnte. (13) What case does in govern, and why? (14) It may be seen, use the indefinite pronoun man, i.e. one may (kann) see it. (15) If somebody has not, say, if nobody has. (16) Say, is really (wirklich).

Key to Exercise 39

The lower regions of the air had been filled for some days with vapours. Only in the night from the 4th to the 5th of July, in the 10th degree of latitude, did we see the Southern Cross clearly for the first time. It was very low and appeared from time to time between clouds, whose midmost part, furrowed by sheet lightning, reflected a silvery light. If a traveller is permitted to speak of his personal emotions, I will add that this night I saw one of the dreams of my earliest youth fulfilled.

When one begins to fix one's gaze on geographical charts, and to read the descriptions of travellers, one feels a sort of preference for certain countries and climes, which cannot be accounted for at a riper (higher) age. These impressions have a noticeable influence on our decisions, and we seek, so to say instinctively, to put ourselves in connection with those objects which for a long time have had a secret fascination for us. At a time when I studied the heavens, not in order to devote myself to astronomy, but so as to become acquainted with the stars, I was stirred by a fear which is unknown to those who love a sedentary life. It seemed to me sad to renounce the hope of seeing the beautiful constellations which lie in the neighbourhood of the South Pole. Impatient as I was to roam through the regions of the Equator, I could not raise my eyes to the starred dome of heaven without thinking of the Southern Cross, and without recalling to memory the elevated passage in Dante which the most famous commentators apply to this constellation.

Key to Exercise 40

Die Prinzeſſin und die Erbſe.

Es war einmal ein Prinz der eine Prinzeſſin heiraten wollte; aber ſie mußte eine wirkliche Prinzeſſin ſein. Er durchreiſte alſo die ganze Welt, aber überall war etwas verkehrt. Prinzeſſinnen gab es die Fülle; aber ob ſie wirkliche Prinzeſſinnen waren konnte er nicht herausfinden, weil immer etwas war das nicht ganz recht ſchien. Er kam infolgedeſſen ſehr niedergeſchlagen nach Hauſe zurück, denn er wollte ſo ſehr gern eine wirkliche Prinzeſſin heiraten.

Eine Nacht erhob ſich ein furchtbarer Sturm; es donnerte und blitzte und der Regen goß in Strömen herunter; es war ganz ſchrecklich. Gerade zu dieſer Zeit wurde an die Pforte des Turms geklopft, und der alte König ging ſelbſt hinunter um ſie zu öffnen.

Es war eine Prinzeſſin die draußen ſtand. Aber großer Gott! in welchem Zuſtand war ſie! Das Waſſer ſtrömte von ihrem Haar und ihren Kleidern, und lief in ihre Schuhſpitzen hinein und an den Hacken hinaus; aber ſie ſagte ſie ſei eine wirkliche Prinzeſſin.

M. A. L.

RUSSIAN.—VIII

The Noun

The Plural of Feminine Nouns

76.—The endings of these nouns are :

Nominative	-ы	-и	-и
Genitive	-ъ	-ь	-ей
Dative	-амъ	-ямъ	-ямъ
Accusative	-ъ	-ь	-ей
	(for living objects)		
Accusative	-ы	-и	-и
	(for inanimate things)		
Instrumental	-ами	-ями	-ями
Prepositional	-ахъ	-яхъ	-яхъ.

(*See* following Table F)

77. *Table F. Full declension of Feminine Plural.*

Original	Фи́рма, *the firm.*	Поте́ря, *a loss.*	Кость, *a bone.*
Nominative	Фи́рмы, *the firms.*	Поте́ри, *losses.*	Ко́сти, *bones.*
Genitive	Фирмъ, *of the firms.*	Поте́рь, *of losses.*	Косте́й, *of bones.*
Dative	Фи́рмамъ, *to the firms.*	Поте́рямъ, *to losses.*	Костя́мъ, *to bones.*
Accusative	Фи́рмы, *the firms.*	Поте́ри, *losses.*	Ко́сти, *bones.*
Instrumental	Фи́рмами, *with the firms.*	Поте́рями, *with losses.*	Костя́ми, *with bones.*
Prepositional	О фи́рмахъ, *about firms.*	О поте́ряхъ, *about losses.*	О костя́хъ, *about bones.*

78. Nouns ending in -га, -жа, -ка, -ха, -ча, -ша and -ща change the -ы of Nominative Plural to -и.

Examples

Кни́га, *a book.*	Кни́ги, *books.*
Ко́жа, *a hide.*	Ко́жи, *hides.*
Рука́, *a hand.*	Ру́ки, *hands.*
Му́ха, *a fly.*	Му́хи, *flies.*
Зада́ча, *a task, problem.*	Зада́чи, *tasks, problems.*
Ча́ша, *a cup, dish, bowl.*	Ча́ши, *cups, dishes, bowls.*

79. Nominatives Feminine Singular ending in -ка with a preceding consonant have the ending -окъ in Genitive Plural.

Examples

	Gen. Plur.
Ло́дка, *a canoe.*	Ло́докъ
Ска́зка, *a tale.*	Ска́зокъ
Па́лка, *a stick.*	Па́локъ
Пома́рка, *a blot.*	Пома́рокъ
Доска́, *a board.*	До́сокъ

80. If -ка is preceded by ж, ч, ш, the Genitive Plural ends in -екъ.

Examples

	Gen. Plur.
То́чка, *a point.*	То́чекъ
Игру́шка, *a toy.*	Игру́шекъ

81. If -ка is preceded by -й, the Genitive Plural also ends in -екъ.

Examples

	Gen. Plur.
Копе́йка, *a copeck.*	Копе́екъ
Хозя́йка, *a housekeeper.*	Хозя́екъ

82. Nouns with ending in -а, if preceded by a consonant and a foregoing ь, change the latter to е in Genitive Plural.

Examples

	Gen. Plur.
Шпи́лька, *a hair-pin.*	Шпи́лекъ
Судьба́, *destiny, fate.*	Суде́бъ

83. Nouns whose ending -я is preceded by a vowel have -й as final letter in Genitive Plural.

Examples

	Gen. Plur.
Ли́нія, *a line.*	Ли́ній
Ко́пія, *a copy.*	Ко́пій
Алле́я, *an alley.*	Алле́й

84. Nouns ending in -ня, with a preceding consonant have -ень, in Genitive Plural.

Examples

	Gen. Plur.
Ба́сня, *a fable.*	Ба́сенъ
Пѣсня, *a song.*	Пѣсенъ

85. Nouns ending in -ыня, or -йня, have -енъ in Genitive Plural.

Examples

	Gen. Plur.
Чита́льня, *reading room.*	Чита́ленъ
Кофе́йня, *coffee house.*	Кофе́енъ

86. The Genitive Plural of дере́вня, *a village*, is дереве́нь, and of земля́, *a land*, is земе́ль.

87. Nouns with Nominative endings -жь, -чь, -шь, -щь, have -амъ, -ами, -ахъ in Dative, Instrumental, and Prepositional respectively.

Examples

Ме́лочь, *a trifle.*	Ме́лочамъ, *to trifles.*
Вещь, *a thing.*	Вещами, *with things.*

88. The Noun са́жень, *a fathom*, has сажёнъ and саженей in Genitive Plural.

89. All numbers from пять, *five*, and upwards require the Genitive Plural after them.

Examples

Пять копе́екъ, *five copecks.*

Де́сять книгъ, *ten books.*

Пятьдеся́тъ бо́чекъ, *fifty barrels.*

Сто дю́жинъ, *one hundred dozen.*

Пятьсо́тъ паръ, *five hundred pairs.*

Practice XXI

(*a*) Change the following into Nominatives Plural :

Ко́мната, *a room.*
Па́ра, *a pair.*
Дю́жина, *a dozen.*
Бо́чка, *a barrel.*
Торго́вля, *a business.*
Глу́пость, *a folly, foolish thing.*

(*b*) Change the following into Genitive Plural :

Ра́зница, *a difference* (*see* Rule 77).
Скаме́йка, *a form* (stool) (*see* Rule 81).
Па́ртія, *a party* (*see* Rule 83).
Цѣль, *an aim* (*see* Rule 77).
Ла́вка, *a shop, bench, form* (*see* Rule 79).
Тесьма́, *a tape* (*see* Rule 82).
Пека́рня, *a bakehouse* (*see* Rule 84).
Вещь, *a thing* (*see* Rule 77).

NOTE.—The **е** replacing **ь** in Genitive Plural of тесьма́ becomes ё (pronounced "yo"), as is often the case with this letter when it *accidentally* takes the accent.

(*c*) Decline the following in Accusative, Instrumental, and Prepositional Plural :

Недѣля, *a week.*
Поку́шка, *a purchase.*
Но́вость, *a novelty, news.*
Газе́та, *a newspaper.*
Ошы́бка, *a mistake.*
А́кція, *a share.*
Запи́ска, *a note.*
Непрія́тность, *an unpleasantness.*
Телегра́мма, *a telegram.*

The Verb

90. *Future of Simple Verbs.*

This is formed of the Future of быть with the Infinitive of the principal verb as exemplified below :

Sing.

1. Я бу́ду рабо́тать, *I shall work.*
2. Ты бу́дешь рабо́тать, *thou wilt work.*
3. Онъ бу́детъ рабо́тать, *he will work.*
3. Она́ бу́детъ рабо́тать, *she will work.*
3. Оно́ бу́детъ рабо́тать, *it will work.*

Plur.

1. Мы бу́демъ рабо́тать, *we shall work.*
2. Вы бу́дете рабо́тать, *you will work.*
3. Они́ бу́дутъ рабо́тать, *they will work,* m.
3. Онѣ бу́дутъ рабо́тать, *they will work,* f.
3. Они́ бу́дутъ рабо́тать, *they will work,* n.

VOCABULARY

Намъ тре́буется (nam tré-bu-yet-sya), *we require.*
Сейча́съ (syei-chás), *immediately, at once.*
Отдѣльнымъ (at-dyél'-nüm) } *under separate cover,*
Конве́ртомъ (kan-vér-tom) } *envelope.*
Прейсъ-кура́нтъ (preis-ku-ránt), *price-list.*
Съ кра́йними (s krái-ni-mi), *with the lowest, utmost.*
То́лько что (tól'-ko chto), *just this minute.*
Руба́шка (ru-básh-ka), *a shirt.*
Согла́сны (sa-glás-nü), *willing* (plur.).
Ждать (zhdat'), *to wait.*
При сёмъ (pri syom), *herewith, hereby.*
Прилага́ть (pri-la-gát'), *to adjoin, annex, enclose.*
Коносаме́нтъ (ko-no-sa-ment), *bill of lading.*
Ма́сло (más-lo), *oil, butter.*
Откры́ть (at-krüt'), *to open, discover.*
Факту́ра (fak-tú-ra), *an invoice.*
Спѣши́ть (spye-shit'), *to hasten.*
Извини́ться (iz-vi-nit'-sya), *to apologise.*
Запи́санъ (za-pi'-san), *is entered,* m. sing.
Пра́вильно (pra-vil'-no), *rightly, correctly.*
Симъ (sim), *herewith.*
Препровожда́ть (pre-pro-vozh-dát'), *to forward, remit.*
Испра́вленный (i-správ-lyen-nui), *corrected,* m. sing.
Удостовѣря́ть (u-da-sta-vye-ryát'), *to confirm, testify.*
Получе́ніе (pa-lu-ché-ni-ye), *the receipt.*
Поко́рнѣйше (pa-kór-nyei-she), *most humbly.*
Благодари́ть (bla-ga-da-rít'), *to thank.*
Любе́зный (lyu-byéz-nüi), *kind,* m. sing.
Запро́съ (za-prós), *enquiry.*
За́втра (záv-tra), *to-morrow.*
Опя́ть (a-pyát'), *again.*
Подтверждать (pat-tver-zhdát'), *to confirm.*
Дѣло (dyé-lo), *the work, the thing.*
Обѣими (a-byé-i-mi), *with both.*
Заказа́ть (za-ka-zát'), *to order, place an order.*
Коли́чество (ka-li-ches-tvo), *a quantity.*
Игóлка (i-gól-ka), *a needle.*
Цу́говица (pú-go-vitsa), *a button.*
Пожа́луйста (pa-zhá-luĭ-sta), *please.*
Церемо́ниться (tse-re-mó-nit'-sya), *to make ceremony.*
Когда́ (ka-gdá), *when.*
Бо́льше (ból'-she), *more* (better).
Успѣхъ (u-spyékh), *success.*
Обѣща́ть (a-bye-shchát'), *to promise.*
Ча́сто (chás-to), *often.*
Керосинъ (ke-ra-sin), *petrol.*
Надѣяться (na-dyé-yat'-sya), *to hope.*
Моско́вскія (ma-skóv-ski-ya), *the Moscow* (adj.).
Бога́ты (ba-gá-tü), *are rich.*
Дождь (dozhd'), *the rain.*
Пробра́ть (pra-brát'), *to pass through, soak through.*
Черпа́ть (cher-pát'), *to draw.*
Зна́ніе (zná-ni-ye), *knowledge.*
Лѣни́выя (lye-ní-vü-ya), *lazy,* f. plur.
Рѣша́ть (rye-shát'), *to solve.*
Сла́дкія (slat-ki-ya), *sweet,* f. plur.
Привлека́ть (pri-vlye-kat'), *to attract.*
Вагóнъ (va-gón), *a wagon-load.*
Въ поря́дкѣ (v pa-ryát-kye), *in good order.*
Образова́ться (ab-ra-za-vát'-sya), *to be formed.*
Намѣрева́ться (na-myé-re-vat'-sya), *to intend.*
Содержа́ть (sa-dyer-zhát'), *to contain.*
Сего́дняшнія (sye-gó-dnyash-ni-ya), *to-day's.*
Интере́сныя (in-tye-rés-nü-ya), *interesting.*
Маши́на (ma-shi-na), *a machine.*
Тамъ (tam), *there.*
Имѣться (i-myét'-sya), (there) *to be.*
Весьма́ (ves'-má), *very.*
Вскóрѣ (vskó-rye), *soon.*

Exercise 13

Translate the following into English :

1. Намъ сейча́съ тре́буется пятьсо́тъ паръ сапо́гъ.
2. Отдѣльнымъ конве́ртомъ посыла́емъ Вамъ нашъ прейсъ-кура́нтъ съ кра́йними цѣнами.
3. Мы то́лько что получи́ли зака́съ на сто дю́жинъ руба́шекъ.
4. Мы согла́сны ждать пять недѣль.
5. При сёмъ прилага́емъ коносаме́нтъ на пятьдеся́тъ бо́чекъ ма́сла.
6. Мы откры́ли въ Вашей факту́рѣ па́ру ошы́бокъ.
7. Спѣшу́ извини́ться за ошы́бки.
8. Вашъ счётъ запи́санъ въ кни́гахъ пра́вильно.
9. Симъ препровожда́ю Вамъ испра́вленный счётъ.
10. Удостовѣря́ю получе́ніе Ва́шего письма́ и поко́рнѣйше благодарю́ за любе́зный запро́съ.
11. Мы Вамъ за́втра бу́демъ телегра́фировать опя́ть.
12. Симъ подтвержда́емъ на́ши телегра́ммы.
13. Я дѣлаю дѣло обѣ́ими рука́ми.

A. C.

Continued from page 98.

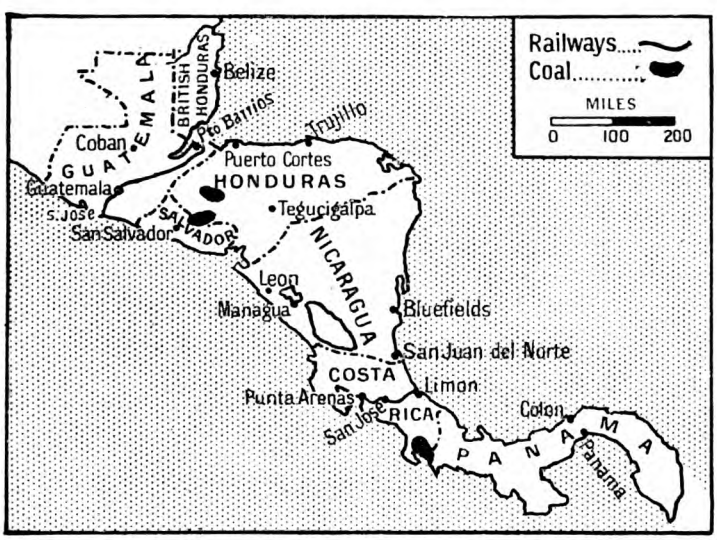
GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D., Cyril J. Silverston, B.Sc.(Lond.).

CENTRAL AMERICA

THE countries comprising Central America are the six republics of Guatemala, Honduras, Salvador, Nicaragua, Costa Rica, and Panama. Physically, there is very little to distinguish one of these countries from another.

In such matters as population and politics, however, there are very noticeable differences. Salvador, for instance, although by far the smallest of the six states, is much the most densely populated.



STATES OF CENTRAL AMERICA
Showing the principal towns, coalfields and railways.

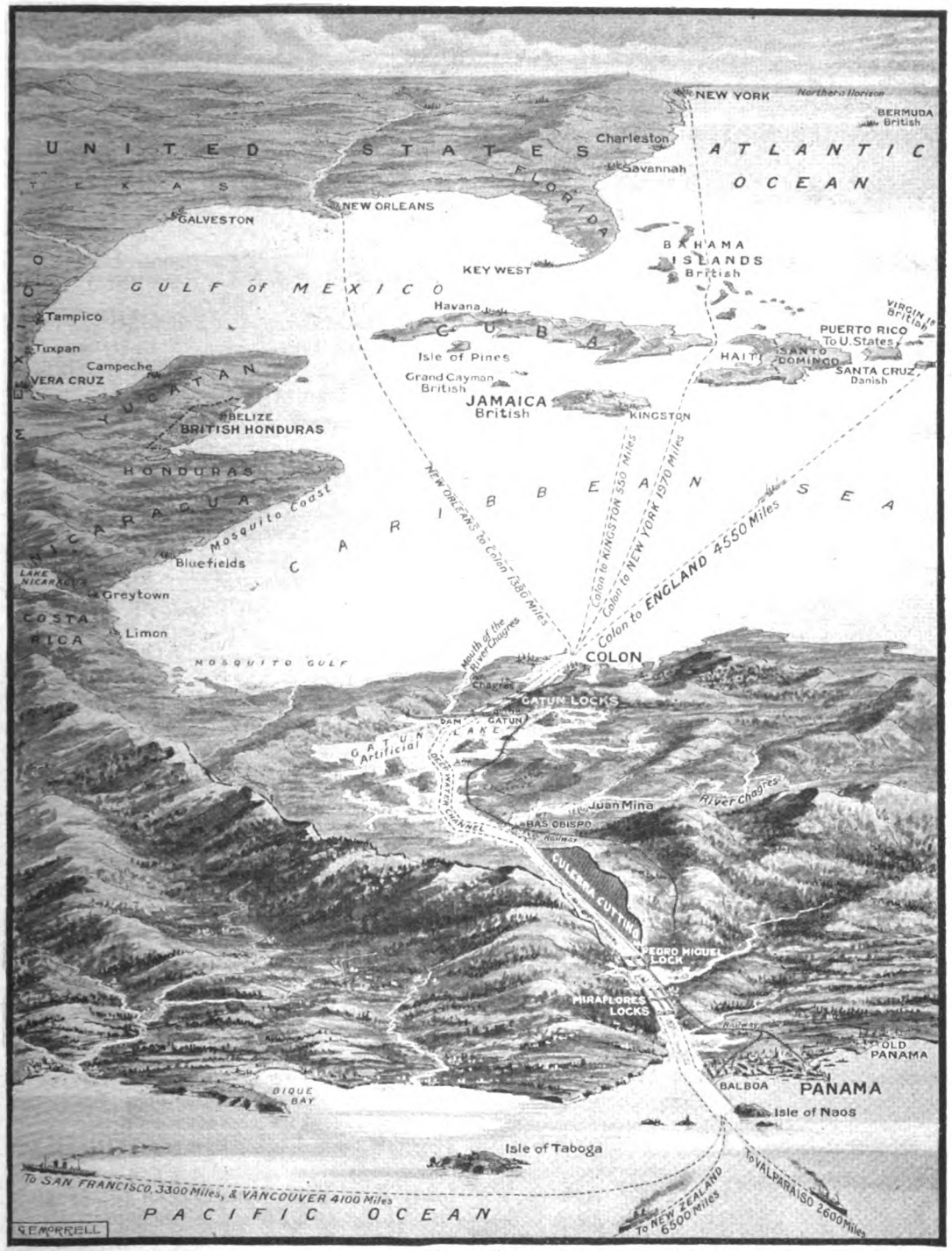
Central America, roughly speaking, may be divided into three zones: the Savannahs and slopes of the Pacific coast, the volcano-studded plateau of the centre, and the low, densely-wooded, rather unhealthy, and immensely fertile Atlantic shore.

The great majority of the towns and settlements of the Central Americans are situated on the igneous central plateau, the altitude of which permits a healthy and comparatively invigorating climate. On the other hand, the danger here from eruption and seismic action is not to be underestimated, and the list of disasters in this respect dates from the earliest days of Spanish colonisation.

Volcanoes, as a matter of fact, are the most salient characteristic natural feature of Central America. They may be said to occur here in actual clusters, so thickly dotted is the earth of these regions with the ominous craters. The highest in Central America is the Guatemalan volcano of Acatenango, which attains to an altitude of 13,616 feet. Nicaragua alone possesses no fewer than seventeen, whether active, quiescent, or extinct, and every state, with the exception of Panama, can lay claim to a corresponding amount.

Although Central America is not actually deficient in rivers, these streams offer very few facilities for navigation, and, very nearly without exception, they suffer from the great disadvantage of shallow bars. The Chagres River in the Republic of Panama is in close proximity to the canal, and, indeed, has been responsible for a number of the difficulties in connection with the construction of this. It has much historical interest, having been largely made use of in the crossing of the Isthmus by the pioneers.

Central America, however, can produce far finer specimens of lakes than it can of rivers. Lake Nicaragua covers an area of some three thousand seven hundred square miles, and is thus the greatest lake between Michigan in the United States and Titicaca in Bolivia. Lake Managua, in the same Republic, although smaller than this, is of great size.



From a drawing by G. F. Morrell, and by courtesy of "The Graphic."

THE PANAMA CANAL AND ITS INFLUENCE ON TRADE ROUTES.

The Canal built by the U.S.A. at a cost of something like £80,000,000 is one of the greatest engineering feats in the world's history. Its utility may be gauged by the fact that it has brought New York 8,000 miles nearer by sea to San Francisco, Liverpool 6,000 miles nearer to San Francisco, and London some 4,500 miles nearer to Honolulu.

The population of the six Republics consists of a small minority of whites, a large number of those of mixed races, known usually as *Ladinos*—corresponding to the *Mestizos* of South America—and an important population of pure-blooded Indians. The percentage of these various races may be gathered from the fact that out of Nicaragua's six hundred thousand inhabitants, it is improbable that more than two thousand are of unmixed white blood.

European immigration into the Isthmus practically has no existence. The West Indies, however, have supplied much labour, and the British negroes have applied themselves in large numbers to the banana industry. Incidentally, it may be said that these were instrumental in the completion of the Panama Canal.

As is only to be expected in an agricultural and pastoral area, Central America possesses no towns of any imposing size according to modern ideas, the largest being Guatemala City, which has a population of about ninety thousand.

The sole Central American ports which possess natural advantages in the way of anchorage are those on the Atlantic shore. Those on the Pacific are, practically without exception—the Gulf of Fonseca alone affording shelter—very little beyond open roadsteads. Panama, of course, possesses the Port of Panama, which stands by itself in the matter of importance.

Fauna of Central America

On the Atlantic coast Guatemala possesses two good ports : Puerto Barrios and Livingston, both much concerned in the banana industry. The Nicaraguan harbour of Bluefields is one of the best in the Isthmus, while, in addition, this state possesses those of S. Juan del Norte, originally known as Greytown, now much neglected, and Cabo de Gracias. Limon is the sole Costa Rican port on the Atlantic, while Panama, in addition to Colon, the Atlantic terminus of the canal, has a rapidly growing commercial port in Bocas del Toro, a banana-shipping centre in the extreme west of the Republic.

The fauna of Central America is very similar to that of the northern Republics of South America. Thus the jaguar, puma, ant-eater, tapir, numerous species of monkey, and other animals of the kind are met with. The greatest variety occurs in the bird-life. One of the most beautiful of these is the quetzal, a bird which is supposed never to live in captivity, and which the Republic of Guatemala has taken for its national emblem.

Lizards, turtles, and tortoises are common, while a peculiar black and white land crab is a feature of the mangrove swamps, and oysters are plentiful in certain districts, especially in the Gulf of Nicoya.

Vampire bats are frequently met with, and the pests of insect life, although not quite so marked here as in the Amazon Valley, abound in great variety.

The land communications of Central America have not yet reached an advanced stage, although a spurt has been observable in various directions since the opening of the twentieth century.

The banana industry has been responsible for important recent strides in the railway industry of Honduras. Many new ventures in the way of light railways, which are known as " banana lines," have been started within the last few years. The object of these, of course, is to bring the fruit from the inland plantations to the ports on the Atlantic, and the development of the banana trade has been very marked as a result.

Panama Canal

The situation as regards these " banana lines " is similar in Costa Rica ; but this progressive Republic has not been content with these local services on the Atlantic coast, but has constructed an inter-oceanic line from Limon, on the Atlantic, to Punta Arenas in the Gulf of Nicoya on the Pacific.

The Panama Railway is much the oldest in the Isthmus, having been constructed by an American Company more than half a century ago. This runs almost by the side of the canal, and it is still being used, having proved of the greatest use on those occasions when the landslides have temporarily blocked the great canal itself.

The influence of this canal must eventually be very great on the countries of Central America, more especially on the Pacific littoral, which, so far as cargo is concerned, now finds itself in a far more favourable situation than it has ever enjoyed before. Since the opening of the canal there have been several troublesome landslides, but there does not seem the least reason to doubt that this difficulty will eventually be completely overcome. A strip of territory, five miles wide, on either side of the canal is now the permanent property of the United States, who administer this by means of their own officials.

Central America has a sufficient variety of products, but the two which are of infinitely the greatest importance are bananas and coffee.

The banana industry is a very recent one, and its development has been remarkably rapid. The best banana districts extend along the lowlands of the Pacific coast. Every state, therefore, is interested in banana plantation with the exception of Salvador, which, possessing no Atlantic coastline, has to content itself with its coffee plantations.

Mahogany Cutting

There is no doubt that this banana industry has revolutionised the life of the Atlantic coast of Central America during the last ten to fifteen years. The Americans have interested themselves very largely in this business, and have not only established a fleet of steamers especially for the carriage of bananas from the Central American ports to New Orleans, but have assisted new plantations, and have built railways in order to open up some of the banana districts more remote from the coast.

The Central American coffee, much of which enjoys very high reputation as to quality, is grown almost entirely on the slopes of the Pacific coast and of the centre. The new Republic of Panama alone exports no coffee. Guatemala, on the other hand, ships the largest quantities, Costa Rica coming second in this respect.

One of the earliest of the Central American industries was that of mahogany cutting, for which the coast of Honduras was especially famed. Very little mahogany is exported now compared with the shipments of former years, the energy formerly devoted to this being required for the banana plantations.

Tobacco-growing, too, which at one time was a staple industry of Honduras, has tended to decrease in importance, although the quality of the Honduranean tobacco is reputed to compare favourably with that of Havana, to which island, as a matter of fact, much of the Honduras tobacco used to be shipped in order to be blended with that of the famous brands. At the present time, however, the production of the Honduranean tobacco does not suffice for the local needs.

Hides are a product of practically every one of the Central American States, the type of cattle bred on the uplands being of the kind which is valuable for its hides.

Photo: Sir H. H. Johnston.

NEW PANAMA, AT THE PACIFIC OUTLET OF THE CANAL.

Cereals and Ores

Other products are timber in general, tropical fruits, rubber, sugar, maize, rice, cocoa, while the European cereals are grown to some extent on the uplands. A certain amount of gold and silver is met with, more especially in Nicaragua and Costa Rica.

The West Indies is an archipelago which extends from Florida in the United States of America to the coast of Venezuela. The islands comprising this archipelago, are usually divided into three or four groups the chief of which are the Bahamas and the Greater and Lesser Antilles. About 40 of the islands are inhabited, and they vary in size from a very few to nearly 45,000 square miles in area.

The Greater Antilles to the north are a disconnected chain of mountains which rise above the sea at intervals and attain their greatest height in San Domingo, of 12,000 feet. The Bahamas are low islands of coral sand and coral. The Lesser Antilles are virtually the tops of submerged mountains, though the outer chain is comparatively low and composed of limestone and coral.

Two of the islands only, Cuba and San Domingo, are independent, the remaining islands belonging to Great Britain, France, the United States of America, &c.

Cuba is the largest of the islands, with an area of 45,000 square miles. The eastern end of the island is mountainous, the middle portion consists of plains covered with sugar-cane, and the western is mountainous with fertile slopes and valleys. It is in this last region that the famous "Havana" tobacco is grown. The capital of the island is Havana, and the chief industries are tobacco-growing and the cultivation of the sugar-cane, though much valuable timber and fruits are exported.

Haiti and Jamaica

San Domingo (*or Haiti*) is the second largest island and is divided into two parts, both republics. The island produces sugar, coffee, tobacco, besides timber, &c. There are also extensive mineral deposits.

Jamaica, the third largest island of the archipelago, and the largest of those belonging to Great Britain, is well wooded and very fertile, the climate being as a rule very pleasant.

The whites, however, form but a small proportion of the population, the remainder being negroes and half-breeds. Sugar and fruits such as bananas, oranges and coconuts are the chief products, but tobacco, coffee, &c., are also grown. The export of rum is large. The capital is Kingston and the total population is under a million.

Our Asphalt Supply

Porto Rico, belonging to the United States, is the next largest island and has a population of over a million, of which about one half are whites. Coffee, sugar and tobacco are cultivated, and there are fine forests of palms, cedar, sandalwood, ebony, &c., and this timber is largely exported.

Trinidad, separated by only a narrow passage from the coast of Venezuela, is the second largest of the British islands in the West Indies. The chief products are cocoa and sugar. The La Brea lake is one of the chief sources of asphalt in the world. The capital of the island is Port of Spain.

Among the other islands one may mention Sta. Cruz, Antigua, Guadeloupe, Dominica, Martinique, Barbados and Tobago. C. J. S.

Photo: Underwood and Underwood.

LA BREA LAKE, TRINIDAD,

one of the chief sources of asphalt in the world. Above is shown the method of removing the pitch.

Continued from page 172.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A.[Lond.]).

ARITHMETIC.—XX

141. Cubes and Cube Roots.—THE cube of a number is the product obtained by taking that number 3 times as a factor. To obtain the cube of a number, it is best to find it by actual multiplication.

142. The Cube Root of a Number is that number which, when taken 3 times as a factor, will give a product equal to the given number.

Occasionally it is possible to factorise a number so as to find its cube root.

Thus find $\sqrt[3]{3375}$

$3375 = 5 \times 5 \times 5 \times 3 \times 3 \times 3 = 5^3 \times 3^3$

$\therefore \sqrt[3]{3375} = \sqrt[3]{5^3 \times 3^3} = 5 \times 3 = 15.$

Mostly, however, the given number is too large to factorise conveniently, and we have to resort to methods similar to those adopted in finding the square root, and based upon the Algebraic formula:

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$
$$= a^3 + (3a^2 + 3ab + b^2)\,b$$

Since $1^3 = 1$ and $10^3 = 1000$, $100^3 = 1000000$, etc., it follows that a number consisting of 1 digit, has 1, 2 or 3 digits in its cube; that a number consisting of 2 digits has 4, 5 or 6 digits in its cube, and so on.

We therefore divide the given number, whose cube root is to be found, into periods of 3, starting from the units' place, and to each period, one digit of the root will correspond.

Examples:—

(1) Find $\sqrt[3]{103823}$

$\sqrt[3]{103,823} = \mathbf{a\ b} = \mathbf{40 + 7}$

$a^3 = 64{,}000$ | $39{,}823$

$3a^2 = 4800$

$3ab = 840$

$b^2 = 49$

$3a^2 + 3ab + b^2 = 5689$ | $39{,}823$

a must be 40 since 103,823 lies between 40^3 and 50^3. Therefore we subtract $a^3 = 64000$ from 103,823. Next we write down $a^2 \times 3 = 4800$ and use that as a trial divisor. This gives us 8 as a quotient, which must be either equal to or greater than the required figure. Now if we add to 4800, $8 \times 3a = 8 \times 120 = 960$ and to this again add $8^2 = 64$, the sum is 5824, and when we multiply this by 8 we get 46592, which is greater than the remainder. Hence we must take $b = 7$. Then we write down $3 \times a \times b = 840$, and then $b^2 = 49$; we add these together, getting $3a^2 + 3ab + b^2 = 5689$ and multiply this sum by $b = 7$, which gives us a product exactly equal to the remainder 39823. In the above we have written out the whole process in full. In the next example we shall omit the zeros on the right in the quotient.

If the cube root consists of more than 2 digits, the above process is repeated.

(2) Find $\sqrt[3]{677761634{\cdot}304}$

$\sqrt{677,761,634{\cdot}304} = \mathbf{878{\cdot}4}$

512

$3 \times 800^2 = 1920000$ | 165761

$3 \times 800 \times 70 = 168000$

$70^2 = 4900$

2092900 | 146503

$3 \times 870^2 = 2270700$ | 19258634

$3 \times 870 \times 8 = 20880$

$8^2 = 64$

2291644 | 18333152

$3 \times 878^2 = 2312652$ | 925482304

$3 \times 878 \times {\cdot}4 = 1053{\cdot}6$

${\cdot}4^2 = {\cdot}16$

$2313705{\cdot}76$ | 925482304

.....

(3) Find $\sqrt[3]{3{\cdot}2}$ correct to 2 places of decimals.

$\sqrt[3]{3{\cdot}2} = \mathbf{1{\cdot}47}$

1

$3 \times 1^2 = 3$ | 2200

$3 \times 1 \times {\cdot}4 = 1{\cdot}2$

${\cdot}4^2 = {\cdot}16$

$4{\cdot}36$ | 1744

$3 \times (1{\cdot}4)^2 = 5{\cdot}88$ | 456000

$3 \times 1{\cdot}4 \times {\cdot}07 = {\cdot}294$

$({\cdot}07)^2 = {\cdot}0049$

$6{\cdot}1789$ | 432523

23477

It is easy to see that the next figure in the quotient will be less than 5, since the last product so nearly equals the remainder

$\therefore$ the result is 1·47.

The decimal point has been retained in the divisors for the same reason as the zeros in the previous example.

143. Surds. Such expressions as $\sqrt{3}$ or $\sqrt[3]{5}$, which can only be found approximately, are called **surds.** They are described as **incommensurable,** because their ratio to unity cannot be expressed by two whole numbers.

Expressions involving surds are said to be **irrational** in contradistinction to such as do not involve surds and are called **rational.**

Any whole number may be expressed as a root. Thus $4 = \sqrt{16} = \sqrt[3]{64}$, etc. Any different roots may be expressed in the form of the same root. Thus $\sqrt[3]{5}$ and $\sqrt[5]{7}$ may be expressed in the following way $\sqrt[3]{5} = \sqrt[15]{5^5} = \sqrt[15]{3125}$, and $\sqrt[5]{7} = \sqrt[15]{7^3} = \sqrt[15]{343}$.

In the above a cube root and a fifth root are both expressed as a fifteenth root.

Between a whole number and a root the sign of multiplication is often omitted. Thus $3 \times \sqrt{3}$ is usually written $3\sqrt{3}$.

The **same roots or surds of the same number may be added and subtracted,** as may their multiples.

Thus $\sqrt{7} + 2\sqrt{7} = 3\sqrt{7}$

$4\sqrt{2} - 2\sqrt{2} = 2\sqrt{2}$

$3\sqrt[5]{10} + \sqrt[5]{10} - 2\sqrt[5]{10} = 2\sqrt[5]{10}$.

But **different roots of the same number and the same root of different numbers cannot be added and subtracted,** but can only be connected by the signs + and −, unless the roots are actually worked out (extracted). Thus $\sqrt[3]{2} - \sqrt{2} + 2\sqrt{7}$ cannot be simplified further except by working out the roots, in which case an approximate result can be obtained. However, **the same roots of different numbers may be multiplied together.**

Consider $\sqrt{2} \times \sqrt{3}$.

If we multiply $(\sqrt{2} \times \sqrt{3})$ by $(\sqrt{2} \times \sqrt{3})$ we get $\sqrt{2} \times \sqrt{3} \times \sqrt{2} \times \sqrt{3} = \sqrt{2} \times \sqrt{2} \times \sqrt{3} \times \sqrt{3} = 2 \times 3 = \mathbf{6}$.

What we have done is to square $(\sqrt{2} \times \sqrt{3})$ and since $(\sqrt{2} \times \sqrt{3})^2 = 6$

$$\therefore \sqrt{2} \times \sqrt{3} = \sqrt{6}.$$

Similarly continued products of the same kinds of roots may be formed.

Thus $\sqrt{3} \times \sqrt{5} \times \sqrt{11} = \sqrt{165}$.

If different kinds of roots are to be multiplied together, they must be expressed as roots of the same kind first.

Thus $\sqrt[3]{2} \times \sqrt{3} = \sqrt[6]{4} \times \sqrt[6]{27} = \sqrt[6]{108}$. Conversely **roots of the same kind may be divided.**

Thus $\sqrt{6} \div \sqrt{3} = \sqrt{2} \times \sqrt{3} \div \sqrt{3} = \sqrt{2}$

and $\sqrt{3} \div \sqrt[3]{5} = \sqrt[6]{27} \div \sqrt[6]{25} = \sqrt[6]{\frac{27}{25}}$

To multiply the sum of two roots or of a whole number and a root by another number or another root, we multiply each separately and add the results.

Thus $(\sqrt{3} + \sqrt[3]{2}) \times 5 = 5\sqrt{3} + 5\sqrt[3]{2}$.

$(\sqrt{5} + \sqrt{3}) \times \sqrt{7} = \sqrt{35} + \sqrt{21}$

$(\sqrt{2} + \sqrt{3}) \times \sqrt{3} = \sqrt{6} + 3$

Similarly when we multiply one sum by another.

$(\sqrt{2} + \sqrt{3}) \times (\sqrt{5} + \sqrt{7})$

$= \sqrt{10} + \sqrt{15} + \sqrt{14} + \sqrt{21}$

$(\sqrt{3} + \sqrt{5}) \times (2 + \sqrt{2})$

$= 2\sqrt{3} + 2\sqrt{5} + \sqrt{6} + \sqrt{10}$.

Consider $\sqrt{12}$.

$\sqrt{12} = \sqrt{4 \times 3} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$

Again $\sqrt[3]{81} = \sqrt[3]{27 \times 3} = \sqrt[3]{27} \times \sqrt[3]{3} = 3\sqrt[3]{3}$

Further $(\sqrt{3} + \sqrt{5}) \times (\sqrt{3} + \sqrt{6})$

$= 3 + \sqrt{15} + \sqrt{18} + \sqrt{30}$

$= 3 + \sqrt{15} + \sqrt{9 \times 2} + \sqrt{30}$

$= 3 + \sqrt{15} + 3\sqrt{2} + \sqrt{30}$.

The difference of two roots, or of a whole number and a root, is treated in an exactly similar manner, as the following will show.

$(\sqrt{3} - \sqrt{2}) \times 5 = 5\sqrt{3} - 5\sqrt{2}$

$(\sqrt{3} - \sqrt{2}) \times \sqrt{7} = \sqrt{21} - \sqrt{14}$.

To multiply a difference by a sum we similarly multiply the difference by each term of the sum and add the results.

Thus $(\sqrt{3} - \sqrt{2})(\sqrt{5} + \sqrt{6})$

$= (\sqrt{3} - \sqrt{2})\sqrt{5} + (\sqrt{3} - \sqrt{2})\sqrt{6}$

$= \sqrt{15} - \sqrt{10} + \sqrt{18} - \sqrt{12}$

$= \sqrt{15} - \sqrt{10} + 3\sqrt{2} - 2\sqrt{3}$.

To multiply a sum by a difference we may proceed in the same way, since the order in which factors are taken is immaterial.

To multiply a difference by a difference we proceed thus:

$(\sqrt{3} - \sqrt{2})(\sqrt{6} - \sqrt{5})$

$(\sqrt{3} - \sqrt{2})\sqrt{6} = \sqrt{18} - \sqrt{12} = 3\sqrt{2} - 2\sqrt{3}$ (a)

$(\sqrt{3} - \sqrt{2})\sqrt{5} = \sqrt{15} - \sqrt{10}$ (b)

We have to subtract (b) from (a).

If we subtract $\sqrt{15}$ from (a) we shall clearly be subtracting $\sqrt{10}$ more than (b) from (a)

$\therefore$ after subtracting $\sqrt{15}$ we must add $\sqrt{10}$.

Hence $(\sqrt{3} - \sqrt{2})(\sqrt{6} - \sqrt{5})$

$= 3\sqrt{2} - 2\sqrt{3} - \sqrt{15} + \sqrt{10}$.

144. A case of great importance arises **when the sum and the difference of 2 roots** or of a whole number and a root are multiplied.

Thus $(\sqrt{7} + \sqrt{3})(\sqrt{7} - \sqrt{3})$

$= 7 + \sqrt{21} - \sqrt{21} - 3 = 7 - 3 = 4$.

Similarly $(2 + \sqrt{3})(2 - \sqrt{3})$

$= 4 + 2\sqrt{3} - 2\sqrt{3} - 3 = 4 - 3 = 1$.

It will be noticed that in these cases the product is rational, and hence $\sqrt{7} - \sqrt{3}$ is called the rationalising factor of $\sqrt{7} + \sqrt{3}$, and vice versa.

When we have a surd in the denominator of a fraction, we can always rationalise the denominator without affecting the value of the fraction, by multiplying both numerator and denominator by the rationalising factor of the denominator. It is clear that the rationalising factor of a single surd is the surd itself.

Examples:—

Simplify:

(1) $\frac{7+2\sqrt{3}}{\sqrt{5}} = \frac{(7+2\sqrt{3})\sqrt{5}}{\sqrt{5}\times\sqrt{5}} = \frac{7\sqrt{5}+2\sqrt{15}}{5}$

(2) $\frac{\sqrt{5}+\sqrt{7}}{\sqrt{6}+\sqrt{3}} = \frac{(\sqrt{5}+\sqrt{7})(\sqrt{6}-\sqrt{3})}{(\sqrt{6}+\sqrt{3})(\sqrt{6}-\sqrt{3})}$

$= \frac{\sqrt{30}+\sqrt{42}-\sqrt{15}-\sqrt{21}}{6-3}$

$= \frac{\sqrt{42}+\sqrt{30}-\sqrt{21}-\sqrt{15}.}{3}$

(3) $\frac{\sqrt{18}}{\sqrt{3}+\sqrt{2}} + \frac{\sqrt{12}}{\sqrt{3}-\sqrt{2}}$

$= \frac{\sqrt{18}(\sqrt{3}-\sqrt{2})+\sqrt{12}(\sqrt{3}+\sqrt{2})}{(\sqrt{3}+\sqrt{2})(\sqrt{3}-\sqrt{2})}$

$= \frac{\sqrt{54}-\sqrt{36}+\sqrt{36}+\sqrt{24}}{3-2} = \frac{3\sqrt{6}+2\sqrt{6}}{1}$

$= \sqrt{6}(3+2) = 5\sqrt{6}.$

Exercise 48

Find the cube roots of

(1) 2197. (2) 117649. (3) 1030301. (4) 32829478·408. (5) 376523·454861. (6) 3·112. (7) ·1850.

The roots are to be correct to 2 decimal places.

Exercise 49

Simplify:

(1) $(\sqrt{5}+\sqrt{3})\times 2$. (2) $(\sqrt{7}+\sqrt{6})\times\sqrt{3}$.

(3) $(\sqrt{2}+\sqrt{3})\times(\sqrt{5}+\sqrt{6})$.

(4) $(\sqrt{7}-\sqrt{5})(\sqrt{7}+\sqrt{5})$.

(5) $(\sqrt{13}+2\sqrt{3})(\sqrt{13}-2\sqrt{3})$. (6) $(\sqrt{21}-\sqrt{14})^2$.

Rationalise the denominators of the following:

(7) $\frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}+1}$. (8) $\frac{3\sqrt{3}-2\sqrt{2}}{4\sqrt{3}-3\sqrt{2}}$. (9) $\frac{\sqrt{6}+\sqrt{2}}{2+\sqrt{8}}$.

Simplify:

(10) $\frac{2\sqrt{3}(1+\sqrt{3}+\sqrt{6})}{(\sqrt{6}+\sqrt{3})(\sqrt{6}+\sqrt{2})(\sqrt{3}+\sqrt{2})}$

(11) Find correct to 4 significant figures the value of $\frac{3{\cdot}1416\times(4{\cdot}73)^2\times{\cdot}0563}{(\sqrt{18{\cdot}2364})^3}$.

(12) Find the value of $\frac{\sqrt{13}-\sqrt{11}}{\sqrt{13}+\sqrt{11}-6}$

correct to 5 significant figures.

(Questions 11 and 12 are from London Matric. Exam.)

Key to Exercise 46

(1) 6·907... per cent. (2) 20 : 23. (3) £523 4s. (4) ·582 per cent. (5) 37·5 per cent. (6) (1) £39 10s. 6d. (2) £121 13s. 2d. (3) £427 14s. 2d. (4) £180 3s. 6½d.

Key to Exercise 47

(1) 24. (2) 25. (3) 47. (4) 193. (5) 726. (6) 1001. (7) 2780. (8) 5942. (9) 7864. (10) 9999. (11) 1·4142. (12) 1·7321. (13) 79·31. (14) 21·8756.

M. A. L.

GEOMETRY.—XVIII

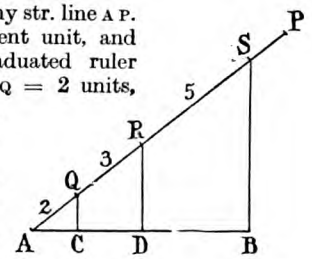
Proposition 116. Problem

To divide a given straight line into parts having given ratios to each other, or having the same ratios as the parts of a given divided straight line.

Fig. 1.—To divide the str. line A B into parts having the ratio 2 : 3 : 5.

Through A draw any str. line A P.

Take any convenient unit, and by means of a graduated ruler mark off lengths A Q = 2 units, Q R = 3 units, and R S = 5 units, on line A P.

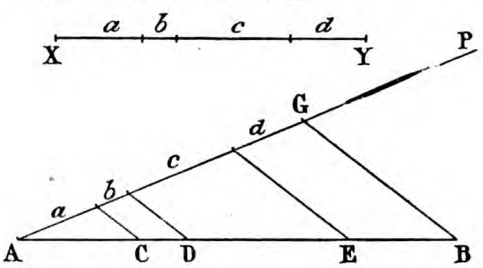


Join S B and draw R D and Q C ‖ to S B cutting A B in C and D.

Then C and D are the points dividing A B as required (Prop. 102).

Fig. 2. To divide A B into parts having the same ratio as the parts, *a*, *b*, *c*, *d* of X Y.

Through A draw any line A P and from A P cut off successive parts = *a*, *b*, *c* and *d*.



Join G, the end of *d* farthest from A, to B and draw ‖s to G B through the other pts. of section of A G, cutting A B in C, D and E.

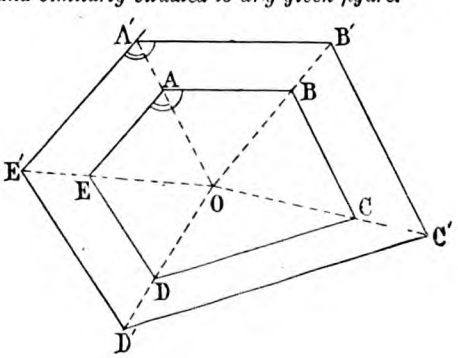
These give the points dividing A B as required (Prop. 102).

Definition.—Two figures are SIMILAR, if each angle of the one be equal to the corresponding angle of the other, and also if each side of the one be proportional to the corresponding side of the other.

If corresponding sides be parallel, the figures are said to be similarly situated.

Proposition 117. Theorem

Any number of figures can be constructed similar to and similarly situated to any given figure.



Let A B C D E be the given figure

Take any pt. O either internal (Fig. 1) or external (Fig. 2).

Join O A, O B, etc.

In O A take any pt. A′.

In O B, O C, etc., find pts. B′, C′, ... such that

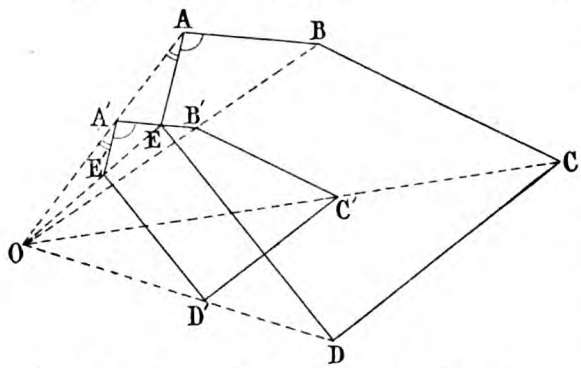
$$\frac{O\,B'}{O\,B} = \frac{O\,C'}{O\,C} = \frac{O\,D'}{O\,D} = \ldots\ldots = \frac{O\,A'}{O\,A}$$

(Prop. 116).

Join A′ B′, B′ C′ . . . . . etc.

Then A′ B′, B′ C′ . . . . . etc., are respectively ‖ to A B, B C, etc. . . . . (Prop. 103)

∴ the ∠s of A′ B′ C′ D′ E′ are equal to the ∠s of A B C D E (Prop. 26).



Now as we have chosen a pt. A′ in O A, the ratio $\frac{O\,A'}{O\,A}$ will = some fixed quantity, say K

and ∵ △s O A B, O A′ B′ are equiangular

$$\frac{A'\,B'}{A\,B} = \frac{O\,A'}{O\,A} = K \text{ (Prop. 108).}$$

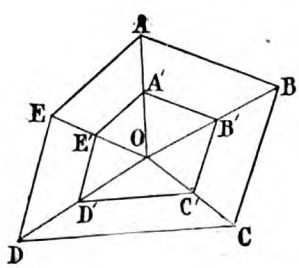
Similarly $\frac{B'\,C'}{B\,C} = \frac{O\,B'}{O\,B} = \frac{O\,A'}{O\,A} = K$ and so on

∴ A′ B′ = K. A B ; B′ C′ = K. B C and so on

i.e. the sides A′ B′, B′ C′ . . . etc., of the polygon A′ B′ C′ D′ E′ are proportional to the sides A B, B C, etc., of the polygon A B C D E.

Proposition 118. Theorem

If two similar figures be placed so that corresponding sides are parallel, they have a centre of similitude.



Let A B C D E, A′ B′ C′ D′ E′ be two similar figures placed so that corresponding sides are ‖.

It is required to show that they have a centre of similitude.

Proof. — Join A A′, B B′ and let them meet at O.

$\frac{A'\,B'}{A\,B} = \frac{O\,B'}{O\,B}$ (∵ A′ B′ is ‖ to A B) (Prop. 108)

$\frac{A'\,B'}{A\,B} = \frac{B'\,C'}{B\,C}$ ∴ $\frac{O\,B'}{O\,B} = \frac{B'\,C'}{B\,C}$

But B′ C′ is ‖ to B C ∴ O C C′ must be a str. line or, in other words, C C′ passes through O.

Similarly D D′ passes through O and so on.

Also $\frac{O\,A'}{O\,A} = \frac{O\,B'}{O\,B} = \frac{O\,C'}{O\,C}$ . . . etc.

∴ O is a centre of similitude.

Proposition 119. Theorem

The ratio of the perimeters of similar polygons is the ratio of their corresponding sides, and the ratio of the areas of similar polygons is equal to the duplicate ratio of their corresponding sides.

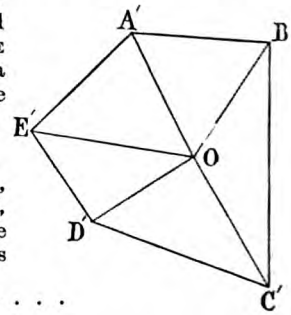
Let A B C D E . . and A′ B′ C′ D′ E′ be similar polygons.

It is required to prove (1) that

$$\frac{\text{perimeter of A′ B′ C′ D′ E′}}{\text{perimeter of A B C D E}} = \frac{A'\,B'}{A\,B}$$

and (2) that $\frac{\text{area of A′ B′ C′ D′ E′}}{\text{area of A B C D E}} = \frac{A'\,B'^2}{A\,B^2}$

Proof.—(1) If A′ B′ C′ D′ E′ be placed similarly to A B C D E then they have a centre of similitude (Prop. 118).



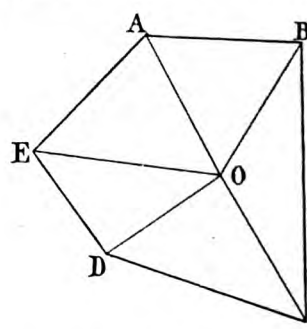
Let it be O.

Then lines O A, O B, . . . etc. and O A′, O B′, etc. divide the polygons into similar △s

∴ $\frac{A'\,B'}{A\,B} = \frac{B'\,C'}{B\,C} = \ldots$

∴ $\frac{A'\,B' + B'\,C' + C'\,D' + \ldots\ldots}{A\,B + B\,C + C\,D + \ldots\ldots} = \frac{A'\,B'}{A\,B}$

i.e $\frac{\text{perimeter of A′ B′ C′ D′ E′}}{\text{perimeter of A B C D E}} = \frac{A'\,B'}{A\,B}$



(2) $\left.\begin{aligned}\frac{\text{area of } \triangle\ A'\,O\,B'}{\text{area of } \triangle\ A\,O\,B} &= \frac{A'\,B'^2}{A\,B^2}\\ \frac{\text{area of } \triangle\ B'\,O\,C'}{\text{area of } \triangle\ B\,O\,C} &= \frac{B'\,C'^2}{B\,C'^2} = \frac{A'\,B'^2}{A'\,B^2}\end{aligned}\right\}$ (Prop. 115)

∴ $\frac{\text{area of } \triangle\ A'\,O\,B'}{\text{area of } \triangle\ A\,O\,B} = \frac{\text{area of } \triangle\ B'\,O\,C'}{\text{area of } \triangle\ B\,O\,C}$

$= \frac{\text{area of } \triangle\ C'\,O\,D'}{\text{area of } \triangle\ C\,O\,D} = \ldots = \frac{A'\,B'^2}{A\,B^2}$

∴ $\frac{\text{area of } \triangle\ A'\,O\,B' + \triangle\ B'\,O\,C' + \triangle\ C'\,O\,D' + \triangle\ D'\,O\,E' + \triangle\ E'\,O\,A'}{\text{area of } \triangle\ A\,O\,B + \triangle\ B\,O\,C + \triangle\ C\,O\,D + \triangle\ D\,O\,E + \triangle\ E\,O\,A} = \frac{A'\,B'^2}{A\,B^2}$

i.e. $\dfrac{\text{area of polygon A' B' C' D' E'}}{\text{area of polygon A B C D E}} = \dfrac{\text{A' B'}^2}{\text{A B}^2}$

Proposition 120. Theorem

Arcs of equal circles have the same ratio to one another as the angles they subtend at the centre.

Let 1 and 2 be equal ○s with centres O and C respectively

and let A B be an arc of 1

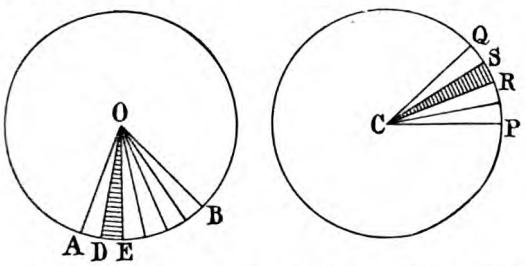
and P Q be an arc of 2.

It is required to prove that

$$\frac{\text{arc P Q}}{\text{arc A B}} = \frac{\angle \text{P C Q}}{\angle \text{A O B}}$$

Proof.—Divide arc A B into any number of equal arcs of which D E is one.

From P Q cut off arcs equal to D E. If P Q does not contain an exact number of these arcs, continue to subdivide the parts of A B until the farthest point



of the last equal part cut off from P Q coincides with Q, or falls so near Q that the difference is imperceptible. Draw radii from O and C to each pt. of division of A B and P Q.

All the sectors thus formed, such as O D E, C R S are equal, and each has the same ∠ at the centre.

There are as many small ∠s in ∠ A O B as there are parts in A B.

And there are as many small ∠s in ∠ P C Q as there are parts in P Q.

$$\therefore \frac{\angle \text{P C Q}}{\angle \text{A O B}} = \frac{\text{arc P Q}}{\text{arc A B}}$$

Corollary.—*Sectors of equal circles have the same ratio to one another as their ∠s at the centre.*

Additional Theorem F.

If a point move so that its distances from two fixed points are in a constant ratio, its locus is a circle.

Let A and B be the two fixed pts.

Let $\frac{r}{s}$ be the constant ratio.

Let P be any pt. on the locus.

It is required to prove that the locus of P is a ⊙

Proof.—Join P A, P B, A B.

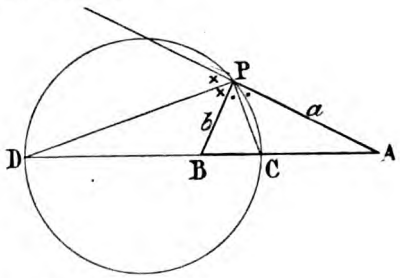
∵ P is a point on the locus, $\frac{a}{b} = \frac{r}{s}$

Bisect the interior and exterior ∠s of △ A P B at P, and let the bisectors cut A B and A B produced at C and D.

$\frac{\text{A C}}{\text{B C}} = \frac{a}{b} = \frac{r}{s}$ (Prop. 104)

$\frac{\text{A D}}{\text{B D}} = \frac{a}{b} = \frac{r}{s}$ (Prop. 106)

i.e. C and D divide A B internally and externally in the same ratio.



∴ C and D are fixed pts.

Now P C is ⊥ to P D

∴ P lies on a semi○ having C D as diameter.

∴ locus of P is a ○ having C D as diameter.

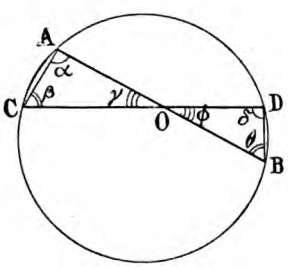
Definition.—A line divided internally and externally in the same ratio is said to be divided **harmonically.**

Proposition 121. Theorem

If two chords of a circle, produced if necessary, intersect, the rectangle contained by the segments of the first chord is equal to the rectangle contained by the segments of the second chord.

Let A B, C D be chords of a ⊙ intersecting at O either internally (Fig. 1) or externally (Fig. 2).

It is required to prove that rect. O A, O B = rect. O C, O D.



Proof. Join A C, B D.

Fig. 1.—In △s A O C, D O B.

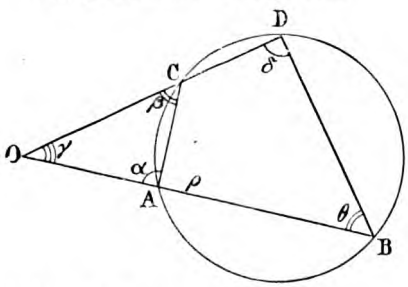
$\alpha = \delta$ } (in same segt. of ○) (Prop. 66)

$\beta = \theta$ }

γ = vert. opp. ∠ φ (Prop. 3)

∴ △s A O C, D O B are equiangular

∴ they are similar (Prop. 108)

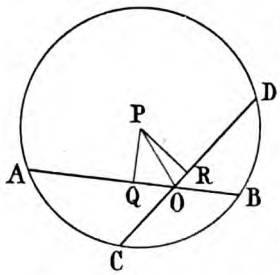


$\therefore \frac{\text{O A}}{\text{O C}} = \frac{\text{O D}}{\text{O B}}$ ∴ rect. O A, O B = rect. O C, O D.

In △s A O B, D O C
Fig. 2.—$\delta + \rho = 2$ rt. ∠s (∵ A C D B are concyclic) (Prop. 67)
$\alpha + \rho = 2$ rt. ∠s (Prop. 1)
$\therefore \alpha = \delta$
Similarly $\beta = \theta$
∴ △s A O C, D O B are equiangular
∴ they are similar (Prop. 108)
$\therefore \frac{O A}{O C} = \frac{O D}{O B}$ ∴ rect. O A, O B = rect. O C, O D.

Alternative Proof for Case (1)

Let P be centre of ⊙
Join O P, A P, D P.
Draw P Q, P R ⊥ to A B, C D respectively (Prop. 22)



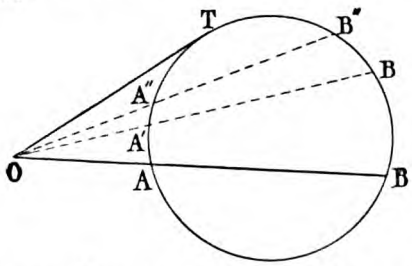
∵ P Q is ⊥ to A B, Q is mid pt. of A B (Prop. 62)
∴ rect. A O, O B = $A Q^2 - O Q^2$ (Prop. 97)
but $A Q^2 = A P^2 - P Q^2$ (Prop. 59)
∴ rect. A O, O B = $A P^2 - (P Q^2 + Q O^2)$
$= A P^2 - O P^2$ (Prop. 59)
Similarly rect. C O, $O D = P D^2 - O P^2$
but A P = P D (radii of ⊙)
∴ rect. A O, O B = rect. C O, O D.

Corollary.—*If two straight lines intersect so that the rectangle contained by the segments of one line is equal to the rectangle contained by the segments of the other line, the four extremities of the straight lines are concyclic.*

(A circle can be drawn to pass through three extremities and it is easy to prove that it must pass through the fourth.)

Proposition 122. Theorem

If from a point outside a circle a secant and a tangent be drawn, the rectangle contained by the segments of the secant is equal to the square on the tangent.



Let O A B be a secant of a ⊙ and let O T be a tangent to it from O.

It is required to prove that rect. O A, O B = $O T^2$.

Proof.—Let O A B revolve round the pt. O through the positions A O′ B′, O A″ B″ until it coincides with O T.

As the secant turns O A becomes longer until O A = O T and O B becomes shorter until O B = O T

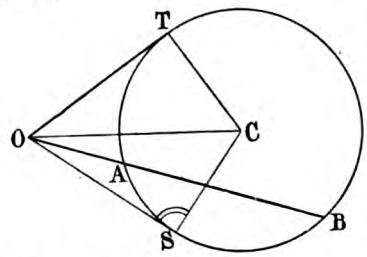
But rect. O A, O B = rect. O A′, O B′ (Prop. 121)
i.e. rect. O A, O B = rect, O A′, O B′ = rect. O A″, O B″
= rect. O T, O T
= $O T^2$

An **alternative proof** on the lines of the alternative proof of the preceding proposition may be given. This is left as an exercise for the student.

Proposition 123. Theorem (converse of Prop. 122)

If from a point outside a circle a secant be drawn and also a straight line meeting the circle, such that the rectangle contained by the segments of the secant are equal to the square on the other line, that line is a tangent to the circle.

Let O A B be a secant to a circle and let O T meet the circle at T.



Let rect. O A, O B = $O T^2$
It is required to prove that O T is a tangent.

Proof.—Draw the tangent O S (Prop. 80)
Join centre C to S and T (Prop. 74)
∠ C S O is a rt. ∠
$O S^2$ = rect. O A, O B (Prop. 122)
$O T^2$ = rect. O A, O B (hypothesis)
∴ O S = O T.
In △s O C T, O C S.
O T = O S
C T = C S (radii)
O C is common
∴ △ O C T ≡ △ O C S (Prop. 8)
∴ ∠ C T O = ∠ C S O = 1 rt. ∠
∴ O T is tangent to ⊙

Exercise 21

(1) What is the locus of a point if the difference of the squares of the distances of the point from two given points is constant.

(2) P, Q are any points on a circle centre O, and A B are two points on the tangents at P and Q such that circles centre A radius A P and centre B radius B Q intersect. Prove that if K is one of the points of intersection, O K is perpendicular to A B.

(3) A B is a chord of length 4·8 inches in a circle of radius 2·5 inches. The radius bisecting A B meets the circle in C. Calculate the length of A C.

(4) From two points S and S′ in the diameter of a semicircle, equidistant from the centre, are drawn parallel straight lines to meet the circumference in Y and Y′. Show that if Y Y′ be joined the angles at Y and Y′ are right.

(5) A B C is a triangle, right-angled at A, and the bisector of the angle A cuts B C in D. If D F be drawn perpendicular to B C to meet A B in E and A C in F, prove that D E = D C, D F = D B, and B E = C F.

M. A. L.

Continued from page 176.

ART AND MUSIC:

Contributors:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

DRAWING.—XII

An important point to bear in mind when drawing trees is that the light falls upon each kind in such a way as to distinguish it from the rest. Thus, the masses of light and shade in the distance tell you the difference between an oak and an elm before ever you can see the difference in the formation of the leaves. The reason for this is that the light and shade show up the shape and individuality of the branches.

The most careful attention, then, should be paid to the light upon a tree, or for that matter on any object you may happen to draw. Light shows up details and makes them recognisable at a distance. It is natural, moreover, to let the eye dwell upon the lighted parts of an object first. It is not until afterwards that you turn to the shadows and try to plumb their obscurity for details.

Tree Drawing

When drawing a tree do not attempt laborious detail, but regard the leaves collectively. Collective masses are just as full of character as the details, only perhaps they are harder for the inexperienced to recognise.

Sir Joshua Reynolds, P.R.A., is very definite on this subject. In speaking of a landscape painter who was famous for his wonderful patience and laborious detail, and who believed that the best result was to be obtained by the exact drawing of each individual leaf on a tree, he expresses the strongest disagreement. Of a particular work he says:—"This picture I never saw, but I am very sure that an artist who regards only the general character of the species, the order of the branches, and the masses of the foliage, will in a few minutes produce a more true resemblance of trees than this painter in as many months."

How then is an artist to obtain the power of rendering a true resemblance with comparatively little work? (By this it is not meant that any good result can be got without hard work, but without unnecessary hard work, which is waste of time very often.) First of all you should learn to make studies of details—separate studies of branches, of the trunk, smaller branches, grass and weeds and so on, which lie in the foreground and must be put into the picture if it is to look at all realistic.

The Secret of Success

Everything worth special notice should be the object of a little exercise all to itself. If you persist in this scheme and learn to use your studies in conjunction with the broad idea of the whole you will succeed in making an admirable drawing.

A well-known landscape painter once told some students that the secret of his success (which was a remarkable one) lay in the fact that he had bestowed a great deal of time upon the close observation of the anatomy of trees: how their branches sprang from their trunks: the forms of their leaves and the manner in which they grow and cluster in masses from the stems.

To return to the practical part of the lesson, you should now study Fig. 70. This represents the leaves of a lime tree and should be carefully drawn, following the old rules laid down above, with an H.B. pencil. You should first sketch lightly in the arrangement of the whole—just as a guide to yourself. This may best be done with a softer pencil.

Begin the actual drawing with the leaves, first those nearest where the stems branch out, doing each leaf in succession according to its exactly right place and leaving none of them out. Then carefully "faint" or erase the arrangement you have made with the soft pencil and draw the stems and any details you have left undone when first doing the leaves.

You will naturally make your drawing much larger than the figure given here. But learn also to draw similar illustrations of the same size. It

is important, particularly at the onset, to draw "big"—because it is then so easy to observe any mistakes you have made for yourself: but you must also learn to draw with equal care on a small scale.

Now try Fig. 69. This should present no particular difficulty, but will prove a good test both of your patience and industry. It will require a good deal of time—far more, if the drawing is to be satisfactory, than might appear at the first glance. Here there are many lights and shadows to be reckoned with. Notice with particular attention the leaves in the midst of the dark mass.

Interior Shadows

Do not on any account attempt to begin the shading until you have the outlines of all the leaves complete. This is a rule which applies universally. Over those leaves to be shaded you should, after you have finished outlining the whole, draw even and close lines indicating the shadow, being careful to leave light spaces on such leaves as are only shaded in part. Cross-hatching may be employed if necessary. A point that requires care and a steady hand is the bringing of your shading lines up to the edge of the leaves. If this is not done the effect is untidy besides failing partially in its object. Do not try to make the shading too dark. That is a mistake. An H.B. pencil is amply sufficient for the purpose.

The making of interior shadows amongst foliage too dark is a common mistake always to be avoided. One reason for not making your shadows too dark is this—it sometimes happens that after you have put on the lines indicating shade you may want to draw in some form which shows up very distinctly in the shadow. This is particularly frequent

Fig. 69.—A good test for patience and industry.

in the drawing of trees. You cannot, of course, make details so plain in shadow as you can in light, but you cannot make them recognisable at all if you have put in a black shadow. Remember too the perspective in trees.

If you draw a wall directly facing you the tones are the same, except for any cast shadows there may be. But trees are not flat: their branches and leaves recede here and project there, so that, whilst leaves in the actual light will be of the same tone (or rather lack of it) those in shadow will vary considerably, some being of a much greater depth of tone than others.

The light falls on the right-hand side in Fig. 69, and consequently comparatively little shading is required there. But away from the light, on the left, the leaves must be toned down, though not so deeply as in the middle of the branch *underneath* the other leaves.

Fig. 70.—Lime Leaves—a useful practice for drawing on a small scale.

A good story may here be told in connection with the question of marking in the salient points of an outline. A young mechanic sought to obtain the post of draughtsman at a factory. It was absolutely necessary that he should be able to draw well. He got the post, and one day his employer brought him several subjects for working drawings. These, said the employer, would no doubt take him four days to complete.

"Marking In"

He had them finished within the twenty-four hours following—and when asked by the delighted employer how he managed it, the mechanic replied that he always saved time by "marking in" his outlines and arranging the drawing carefully, plotting where each part of the subject was situated in relation to the whole. By this means he avoided a great deal of the constant rubbing out of false lines which wastes the time of so many draughtsmen.

Figs. 71 and 72 will provide another useful exercise to be repeated several times. First of all before copying the whole, it will be a good plan to make studies of various parts as you would do in drawing direct from nature. A Scotch fir is always a fascinating object to draw and gives an admirable example of foliage which is not extraordinarily difficult to represent really well and which amply repays the trouble bestowed on it.

You should first outline the trunk of the tree, after which indicate the branches springing from it. Then mark in the general forms taken by the various groups of foliage. To keep to this order is important, for these reasons: the trunk and branches are the skeleton, so to say, of the tree, and upon them depends the character of the general outline. Therefore they must come first.

The masses of foliage are dependent for their general formation on the branches which hold them. After the outlining, put in the shadows. The half-tones are especially important because they give the appearance of *roundness* where it is

required. Fig. 71 shows the tree treated in outline with the first touches of shade upon it. Fig. 72 shows the drawing completed in detail.

It is a curiously frequent mistake on the part of beginners to *begin* the drawing of a tree with the shading. They forget that it is the trunks and branches on which the shaded foliage depends.

Fig. 71.—A Scotch Fir—the skeleton outline.

It is here worth while saying a little on the subject of foregrounds, which when making a drawing from nature loom large in importance. Foregrounds you naturally associate with such objects as clumps of grass, shrubs, bushes, brambles, creepers and stumps of trees. Here as elsewhere it is necessary to go to nature for examples and for exercises to be practised. Most of the remarks made upon the drawing of trees apply equally to shrubs and the smaller fry of vegetable growth generally.

Many artists gather plants by the roots and pot them in order to have objects to copy always by them. Studies can be made of these which materially help the collective observation of a whole foreground of hedge or moor or woodland. This is a good practice, but always remember that you are an artist and not a botanist.

On Detail

The landscape painter Burnet has excellent advice on the subject of foregrounds. "To begin with, the foreground," he writes, "being that part of the landscape nearest the eye, it is necessary, therefore, that it should receive all those qualities conducive to its situation—such as detail, breadth and largeness of parts.

"In the early stages of the art, the minutiæ of individual plants and flowers were carried to the highest pitch of absurdity: not only is the whole ground of these pictures inlaid with endless specimens of botanic scrupulosity, but the intervening spaces are filled with reptiles and insects, as if the lives of the artists had been of an antidiluvian length."

It very often happens that, when drawing foliage in particular, you wish to keep the sharp splashes of light such as appear on the surface of water, on leaves and grass, clouds, and other objects. When working over a drawing with pencil and india-rubber it is sometimes difficult to do this and to keep the parts quite clear and clean. The method for obviating this may savour of trickery to some people, but it is quite legitimate.

A Valuable Hint

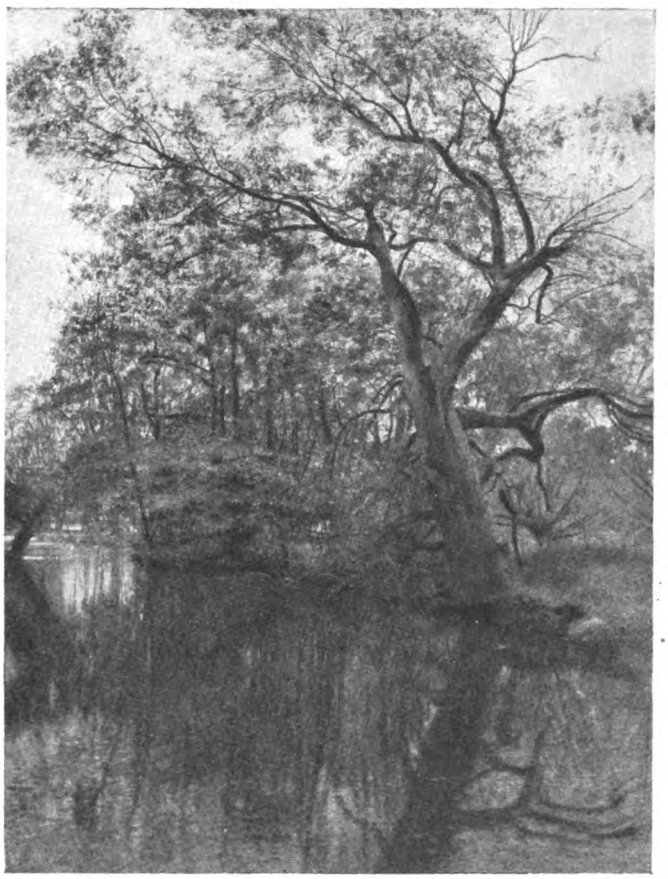
After you have drawn the objects surrounding the part you wish to remain bright or the outline of a bright object, you should take some strong gum-water and into it dip the point of a fine camel's-hair brush. Paint over the whole of the part you wish to remain white. Leave it to dry, and then go on with your drawing.

Fig. 72.—A Scotch Fir—the finished drawing.

When you have completed your drawing prop it up, still pinned to its board, at a slant and pour a little hot water over it. The gum then melts and passes off; and the places covered by it are then snowy white. If also you have larger spaces on which a bright light is supposed to shine and which

have certain hardly defined details upon them, you can treat these in the same way, and when the gum has been washed off you can then draw upon the clean surface.

Gum-water may also be used for fixing a drawing. By this is meant the preservation of a pencil or chalk drawing against smudging by rubbing against other drawings or papers. It is always just as well to keep gum work if only to compare your earlier with your later efforts. Besides after a time, however modest your personal feelings may be towards your work, there will certainly be some drawings which satisfy you more or less. These you may wish to keep or to give away; and in either case you naturally desire to preserve them, so far as is possible, against ordinary wear and tear.



A STUDY IN FOLIAGE AND REFLECTIONS.

A characteristic example of the work of Vicat Cole, R.A.

Procure a shallow dish or very large plate rather larger than the drawing you are going to treat. Fill it or nearly fill it with a weak solution of gum-water, or what is really just as useful a mixture of milk and water, half and half. Some people use milk alone. Hold your drawing by two of its edges and drag it slowly through the bath, with the face uppermost.

Be perfectly sure that the whole surface has been wetted. You can then hang it by one corner pinned to the wall, where the mixture will drip off it and dry. Sufficient milk or gum will be left, however, to form a protecting film over the drawing.

Another way of doing this is to pin your drawing on a board held on an incline over a dish and to pour the mixture over it with an egg cup or large spoon, baling the liquid out of the dish just as you bale out a boat.

Where there is very little shading and no danger of smearing the lead or chalk you may *paint* the liquid on the drawing with a large brush. But the more generous method is on the whole the better one. J. G. B. L.

BOOK ILLUSTRATION.—III

We now come to the vexed question of illustrations for fiction; that is, ordinary fiction for adult readers—the popular novel, in fact. Writing from the purely literary point of view, illustration is an undoubted mistake. The novel should require no explanatory embellishments, but this is not the question that concerns us now. Novels are occasionally illustrated, and the problem is how to set about it.

Of course, fiction was much more copiously adorned with pictures thirty years ago than at the present time. It is difficult to say why exactly, because, taken as a whole, the public have grown far more accustomed to whatever saves thinking and the use of imagination.

Many readers of novels tell you that they prefer to picture their heroines and heroes in their own minds and resent the impertinent interpretation of an artist. That is an extremely sensible view. Again, books that were illustrated years ago by a particular man are treasured in our hearts: we grew

accustomed to the pictures as children, we saw this or that character portrayed for all time, and as such they must ever remain.

And then a new edition of the book is published with brand-new illustrations by, very likely, an artist of undisputed talent whose work we have personally admired. But the impertinence of it remains. We see our old friends drawn strange and new with foreign observation, and in some cases the old illusion is spoiled.

Many hearts were outraged when Lewis Carroll's *Alice* was pictured anew, though by a highly competent and engaging hand.

Old Associations

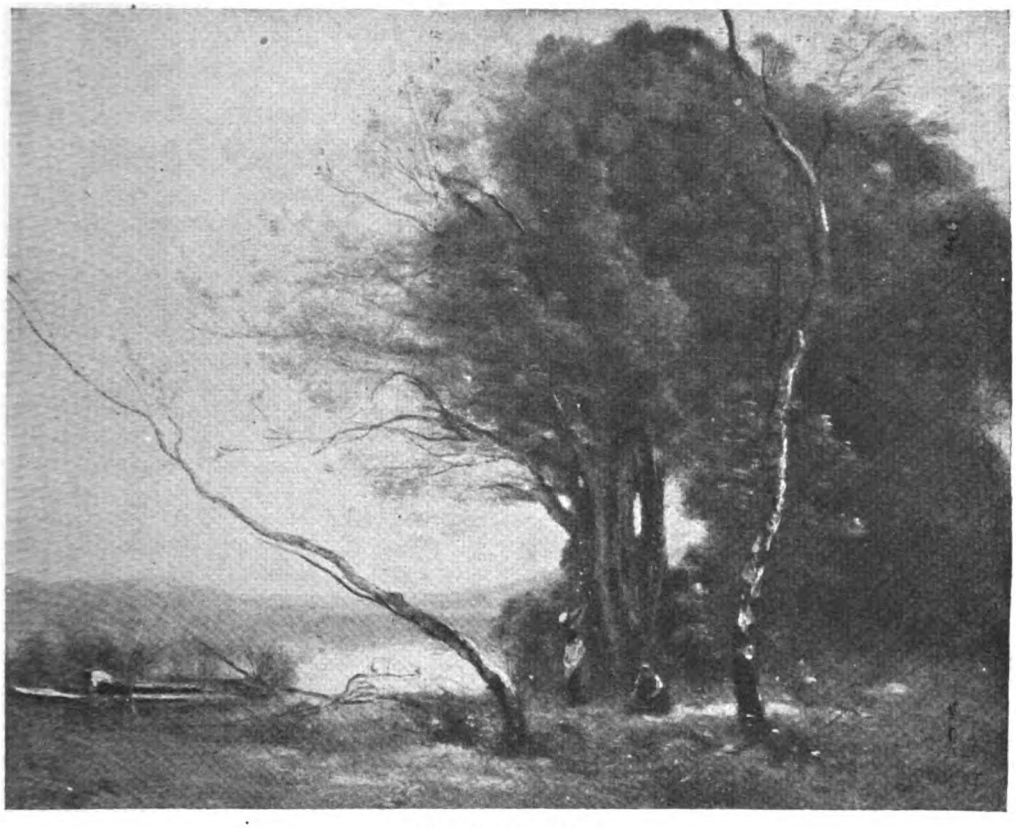
As children we knew *Alice* illustrated—inadequately and wordingly enough in many estimations—by the late Sir John Tenniel. But old association has its way with us and we don't wish to see *Alice* done by an alien pen.

But to come to the practical problem of illustrating books. How is the work to be approached? In the first place the story must be very carefully read. Again and again have I observed clean-shaven heroes pictured with a moustache or beard, and even factory girls with tiaras in their hair. The artist *will* not read the tale, *will* not take the elementary trouble to be true to the life of the book. He has plenty of excuse, though. It is extremely hard to work upon another person's idea, a most ungratifying task for an original mind.

Choice of Subject

Then (and this is much harder) comes the choice of subject. If there are dramatic scenes in the book the artist will probably pick upon them. But how seldom are dramatic scenes in a tale capable of dramatic interpretation in the other medium?

If the artist can convey, after long consultation with the author, some adequate idea of particular characters he will have achieved perhaps the most useful task from the publisher's point of view. And that is why even in dramatic or melodramatic books the most ordinary and commonplace scenes are often depicted. J. G. B. L.



THE BENT TREE.

One of the incomparable studies of the famous French landscape painter Jean-Baptiste Corot (1796–1875).

Continued from page 184.

BUSINESS AND COMMERCE:

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

CHOOSING A CAREER.—XX

The Home Police Forces (*Concluded*)—

THE Police Forces of the capital were dealt with in the preceding article—namely, the Metropolitan Police Force; the City of London Police and the Thames Police (pp. 180, 181).

Turning now to the **Edinburgh City Police,** the conditions of enlistment naturally vary from those given in our opening part for the other services. In the first place, candidates must be over 20 years of age but under 25; except in those cases where they are to be transferred from other forces, or where they have served within the preceding three months in the Royal Navy, Army or Air Force, when the age limit is raised.

The minimum height required is 5 feet 10 inches without boots, and applicants should be of strong build, free from bodily complaints, possessed of a sound constitution, smart in appearance and address, of proved good character and undoubted sobriety.

Further, they must be able to read intelligently and to write a fair hand; and candidates before their appointment are examined by the official Police Surgeon as to their physical fitness.

Applications for appointment should be made on forms to be obtained for the purpose from the *Chief Constable, Edinburgh City Police, Edinburgh.* These forms are styled the "candidate's schedule," and the particulars required are to be given in the space under the heading: "Examination of Candidate."

This form should be accompanied by a certificate of character signed by the applicant's last employer and by not fewer than two magistrates, clergymen or gentlemen of position who have had a personal knowledge of the candidate during the previous two years. A certificate of birth should also be enclosed; and, in the case of the candidate having served in the Navy, Army or Air Force, his papers of discharge.

In this Force constables serve for a probationary period of three months and the pay compares favourably with that of other Forces. In the course of each year there are fifty-two days' leave, comprising annual holidays, 11 days; 2 days' leave each month; and every third Sunday.

In the **Dublin Police Force** the limits of age are from 20 to 26 years; the minimum height 5 feet 9 inches, and there are the usual searching tests as to the man's physical fitness and constitutional strength. A fair standard of education is required and candidates should possess a good general knowledge.

Candidates should make application for an official form and schedule to the *Commissioner, Dublin Metropolitan Force, Dublin;* and when returning this form, duly filled in, it should be accompanied by testimonials from a magistrate, clergyman or other gentleman of standing. In this Force, as with most others, promotion is invariably from the ranks.

In other parts of England, Scotland and Wales, there are City Police Forces or **County Constabularies,** and the conditions of pay and employment vary slightly with each, according to the locality and circumstances; city policemen being usually paid more than those engaged on beats in the open country. In each case the best plan is for a candidate to inquire at the local Police Station; or else to make written application to the Chief Constable of the particular force he wishes to join.

As a general rule the age limits are from 20 to 25 or 27 years, with extensions in favour of ex-Service men. The standard of minimum height is usually about 5 feet 9 inches, and in practically every force an officer has the opportunity to work his way from the lowest to the highest grade and to qualify for a pension.

Certainly police work has never been more attractive or better paid than at present, and the service is full of the brightest prospects which are drawing young men of an education superior to that of the elementary school.

We come now to a Force that differs materially from the other police bodies of the United Kingdom, the **Royal Irish Constabulary.** This fine body of men—its present strength exceeds 10,000—is very highly trained on military principles and the police stations are termed " barracks."

In fact, men of the Royal Irish are almost as much soldiers as they are policemen, from the point of view of the Englishman ; and they perform many duties that do not in the ordinary way fall to the lot of the average constable in either of the sister kingdoms.

So far as the cadets or officers are concerned, they are selected for appointment by an examination of limited candidature conducted by the Civil Service Commissioners ; but in every case the original nomination is vested in the Lord Lieutenant of Ireland for the time in office.

The limits of age are from 21 to 26 years ; though in a few special instances an extension may be permitted. The physical qualifications are a minimum height of 5 feet 8 inches, and freedom from defects of sight, hearing and speech. In every case, candidates must be unmarried.

The subjects of the literary examination embrace letter writing, Latin or French, the elementary principles of law and the laws of evidence ; and candidates who are successful with the examination must possess a private income or allowance of at least £50 a year to supplement their pay whilst they are being instructed in their duties. It may be mentioned also that the cost of uniform and equipment has to be borne by the candidate.

Beginning as cadets, the officers are promoted to the position of District Inspector. There are 17 District Inspectors of the 3rd Class ; 90 of the 2nd Class ; 88 of the 1st Class, and 36 County Inspectors, as well as the City Inspector of Belfast. The cadets are trained at the Phœnix Park Depot, Dublin.

So much for the officers of the R.I.C. Turning now to the ranks, the limits of age are from 19 to 27 years ; and there is a minimum height standard of 5 feet 9 inches, without boots, and a minimum chest measurement of 36 inches. Candidates are subjected to a stringent medical examination to prove that they are sound in wind and limb and free from any detracting physical defects.

There is also an educational examination of quite a simple character in the familiar three subjects—reading, writing, and the first four rules of arithmetic.

So far as allowances go, they are very much on military lines, with free uniform and equipment, free quarters in barracks and so on. The recruit passes through a probationary period and is then appointed constable on full pay ; from which time his wages rise in fixed increments, whilst he may be promoted to be sergeant or Head Constable.

The Royal Irish Constabulary should commend itself to the young man of keen intelligence who is fond of an outdoor life and who wishes to set out on a definite life-long career. The latest details as to pay, etc., may be obtained from any Police Barracks in Ireland, and applicants should make written application to either of the County Inspectors for instructions as to joining.

In previous lessons we have dealt fully with the Colonial Police Forces, but no chapter on the police of the United Kingdom would be complete without making the point concerning official **Detectives** perfectly plain.

In none of our Police Forces can a candidate become a detective straight away. There is only one method of entering the detective department of a police force and that is by joining as an ordinary constable, wearing the uniform and doing the work of a policeman.

Promotion from the ranks of the constables to those of the detectives is purely a matter of ability and personal merit.

The same remarks apply to the **Criminal Investigation Department** at New Scotland Yard, London, which is recruited almost exclusively from the ranks of the Metropolitan Police Force.

Detectives are descendants of the old " Bow Street Runners " or " Robin Redbreasts," as they were called after their scarlet waistcoats. Their work was to follow up any serious crime at the request of private persons, and on the authority of sitting magistrates. In 1829 when Sir Robert Peel reorganised the police force the runners disappeared. About fifteen years later a few constables in plain clothes undertook their work, and at first numbered only about a dozen. The number gradually increased as years went by.

A. C. M.

BOOK-KEEPING.—XIV

PERSONS in partnership usually remain so for a more or less lengthy period, extending their business by their joint efforts.

Joint Speculation

There are cases, however, where persons become partners for a specific purpose, the partnership ceasing when that purpose is accomplished. It may be for the sale of a special parcel of goods, and when the goods are disposed of, the joint co-operation of the parties terminates. In such a case, from a purely book-keeping point of view the transaction may be called a "joint account," a "joint speculation," or a "joint consignment," according to circumstances.

Let it be assumed that you have agreed to carry through a certain transaction involving a joint account with Cecil Burnes. You buy for this joint account goods valued at £600 from Matthew Renshaw. Renshaw will be credited in your books, and the joint account will be debited.

Cecil Burnes pays you by cheque half of the cost of the goods, viz. £300.

This item will be duly entered in the Cash Book.

When the goods are delivered, you are called upon to pay certain charges for carriage, etc., amounting to £20. This amount must necessarily be debited to the Joint Account, and the entry for the payment will be made in the Cash Book as follows :—

CASH BOOK

		PAYMENTS								
		Dis.			*Cash*			*Bank*		
		£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
By Joint Account								20	–	–

Supposing a trader sees an opportunity for disposing of certain goods on very advantageous terms, but is not able to command sufficient capital to enable him to carry the transaction through on his own account : he may approach another trader with the suggestion of a joint adventure. The student who has worked through the two previous lessons and exercises will have little difficulty with joint accounts.

You are successful in selling part of the goods received on the Joint Account for £450, to Rowland Hall, and the remainder to Mark Dixon for £320. The buyers will be debited, and the Joint Account credited, as follows :—

JOURNAL

		£	*s.*	*d.*	£	*s.*	*d.*
Rowland Hall	*Dr.*	450	–	–			
Mark Dixon	*Dr.*	320	–	–			
To Joint Account					770	–	–

You now pay Matthew Renshaw, from whom the goods were bought, in the following way, viz., (a) by cheque for £350; (b) by bill at three months :—

CASH BOOK

		PAYMENTS								
		Dis.			*Cash*			*Bank*		
		£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
By M. Renshaw								350	–	–

JOURNAL

		£	*s.*	*d.*	£	*s.*	*d.*
M. Renshaw	*Dr.*	250	–	–			
To Bill Payable					250	–	–

As you are carrying the transaction through, it is agreed between your partner and yourself that you shall be reimbursed for your trouble by a commission, the amount of which is fixed at £10. This is your recompense for finding the customers and disposing of the goods. So far as you are concerned, this is a gain, and a charge against the Joint Account. It will therefore be journalised thus :—

JOURNAL

		£	s.	d.	£	s.	d.
Joint Account	*Dr.*	10	–	–			
To Commission					10	–	–

The buyers of the goods each pay you by means of a cheque the amount owing, and these payments will be recorded in the Cash Book as follows :—

CASH BOOK

RECEIPTS.	*Dis.* £	*Dis.* s.	*Dis.* d.	*Cash* £	*Cash* s.	*Cash* d.	*Bank* £	*Bank* s.	*Bank* d.
To Rowland Hall							450	–	–
„ Mark Dixon							320	–	–

When the various items dealt with above are posted to their respective Ledger Accounts, the result of the transaction can be seen at a glance. The Joint Account is debited with the cost of the goods and charges, and credited with the proceeds.

Profit or Loss

When this has been done, the difference will represent profit or loss. It has been agreed that this shall be shared equally between the two partners to the transaction, and it will be found that the gross profit shown is £140. Half this amount (viz. £70) will be transferred to your Profit and Loss Account and half to the personal account of your partner, Mr. Burnes. Mr. Burnes's account will now show him to be entitled to £370, this sum being made up of his contribution towards the cost of the goods, plus his share of the profit on the joint transaction.

The completed Ledger Accounts are shown on p. 246. They include, besides the accounts with the partner and traders, the bill payable account, the commission account, and the profit and loss account.

Petty Cash may be defined as the money which is required in a business for the purpose of small incidental expenses, such, for example, as pens or pencils, sealing wax, tram fares, window cleaning, etc., where the items are too small to warrant inclusion in the general Cash Book. The keeping of the Petty Cash Book is often entrusted to a junior clerk, who thus gets an opportunity of dealing with cash in small amounts, and gains experience which will fit him in due course to accept greater responsibility.

The Petty Cash Book is usually kept on what is known as the "imprest" system, which is explained in detail in Lesson XV. A fixed amount is transferred from the ordinary cash to the keeping of the Petty Cashier. At the end of a certain period, sometimes a week but more frequently a month, the Petty Cash Book is carefully made up.

The exact sum paid out during the period is then transferred from the General Cash to the Petty Cash, bringing the balance in hand up to the original amount with which the book was opened.

The following illustration will make the matter clear :—

Suppose William Wright is appointed Petty Cashier on the 1st January, and the sum of £10 is handed to him for disbursement. During the month of January he pays out in different amounts a total of £8 5s.

On the last day of January he then applies to the Cashier for that amount, which is duly handed to him, so that he is able to carry forward in his Petty Cash Book on the 1st February the balance of £10, which is the precise amount with which he started on the 1st January.

Dr. JOINT ACCOUNT WITH CECIL BURNES *Cr.*

	£	s.	d.		£	s.	d.
To M. Renshaw ..	600	–	–	By R. Hall	450	–	–
,, Cash (charges) ..	20	–	–	,, M. Dixon ..	320	–	–
,, Commission ..	10	–	–				
,, Cecil Burnes (half of profit) ..	70	–	–				
,, Profit and Loss Account (do.) ..	70	–	–				
	770	–	–		£770	–	–

Dr. MATTHEW RENSHAW *Cr.*

	£	s.	d.		£	s.	d.
To Cash	350	–	–	By Joint Account ..	600	–	–
,, Bill Payable ..	250	–	–				
	£600	–	–		600	–	–

Dr. CECIL BURNES *Cr.*

	£	s.	d.		£	s.	d.
				By Cash	300	–	–
				,, Joint Account (half of profit) ..	70	–	–

Dr. ROWLAND HALL *Cr.*

	£	s.	d.		£	s.	d.
To Joint Account ..	450	–	–	By Cash	450	–	–

Dr. MARK DIXON *Cr.*

	£	s.	d.		£	s.	d.
To Joint Account ..	320	–	–	By Cash	320	–	–

Dr. BILL PAYABLE ACCOUNT *Cr.*

	£	s.	d.		£	s.	d.
				By M. Renshaw ..	250	–	–

Dr. COMMISSION ACCOUNT *Cr.*

	£	s.	d.		£	s.	d.
				By Joint Account ..	10	–	–

Dr. PROFIT AND LOSS ACCOUNT *Cr.*

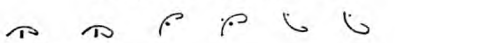
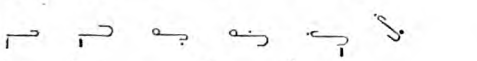
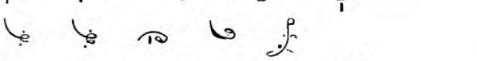
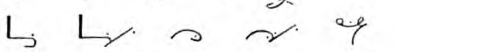
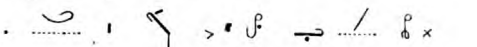
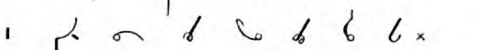
	£	s.	d.		£	s.	d.
				By Joint Account ..	70	–	–

SHORTHAND.—XI

Key to Exercise 40

1. position, positions, possession, possessions, transition, transitions, musician, musicians.
2. fashionable, actionable, commissioner, national, exceptional, educational.
3. situation, station, extension, extenuation, insinuation, transposition, sectional.
4. portion, derision, flotation, agitation, application, pan, passion, conversion, conversation.
5. *There*-seems-*to-be* some *justification for-the* error *in the* specification.
6. *We-are sure you-will-have satisfaction in* dealing *with-the* Russian firm.
7. *All should-be* aware *of generalizations which-are so often* taken *as* being *true.*
8. *The satisfaction given to-the* electrician shows *the justification of-the generalization.*

Key to Exercise 41

1. 
2. 
3. 
4. 
5. 
6. 
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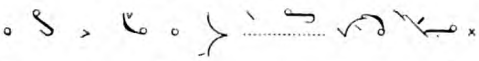
8. 

Compound Consonants.—The following words—

*qu*ell, lin*gu*ist, *wh*ere, *well*, *wh*eel, fow*ler*, sha*rer*, da*mp*, e*mb*arrass

contain respectively the letters—

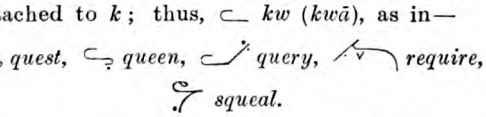
qu, *gu*, *wh*, *w-l*, *wh-l*, *ler*, *rer*, *mp*, *mb*,

having the sounds of—

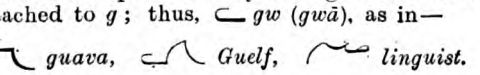
kwā, *gwā*, *hwā*, *wel*, *hwel*, *ler*, *rer*, *emp*, *emb*.

These are called compound consonants, and are represented as follows—

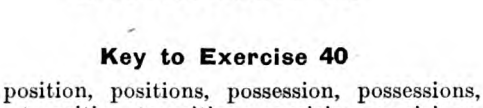
Kwā is represented by a large initial hook attached to *k*; thus, *kw* (*kwā*), as in—



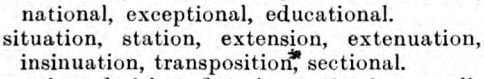
Gwā is represented by a large initial hook attached to *g*; thus, *gw* (*gwā*), as in—



Hwā is represented by as in—

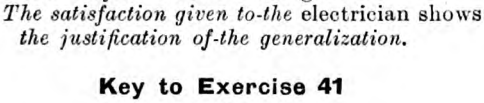


The following pairs of words should be carefully noted—



Wel is represented by which is made up of a small initial hook added to *l* (up).

Hwel is represented by which is made up of a large initial hook added to *l* (up). Both and are vocalised in the same way as *sl*; thus—

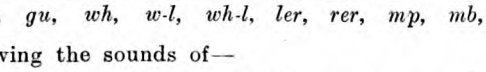


As the small and the large hook are initial, they must be read first; therefore, when a vowel precedes *wh*, the sign must be written, as in—

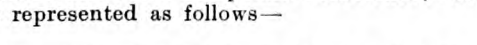
Ler is represented by which is a thickened downward *l*, and may be written to represent words containing the syllables *-ler*, *-lar*, *-lor*, *-lour*; thus—

The *-ler* sign is used where downward *l* is allowed to be written; hence, the following are written—

but the *-ler* is not used to indicate the derivatives of words having the upward *l*; thus—



When a vowel follows the *-ler* sound, the compound consonant is not used, as in



Rer is represented by which is a thickened downward *r*; thus—

As in the case of *-ler*, the *-rer* is used where downward *r* is allowed.

Mp, Mb.—Thickening the alphabetic stroke *m* adds *p* or *b*; thus, *mp*, *mb*, as in—

impure, *embitter*.

When a vowel occurs between the two consonants, the separate strokes must be used, as in—

map, *Mab*; *mop*, *mob*.

Further examples are as follows—

Sambo, *stump*, *swamp*, *impose*, *embossed*, *imposes*, *ambition*, *impugn*, *champagne*.

When *mp*, *mb* is initially hooked for *r*, the syllable *-er* is added; thus—

lumber, *whimper*, *cumber*.

The outlines for the words *embrace*, *embarrass*, *employ*, *impel*, are worthy of consideration. They are as follows—

and illustrate the rule that when *r* or *l* immediately follows *mp* or *mb*, the hooked sign is preferred. Other examples are—

empress, but *emperor*;

umbrella, but *embark*;

ample, *scramble*, *sample*.

Any of the compound consonants may be used medially if a good joining results; thus—

vanquish, *exquisitely*, *Maguire*, *unwillingness*, *fly-wheel*, *secularly*, *lumbago*, *trumpet*, *anywhere*, *nowhere*.

NOTE.—Particular attention should be given to the two last examples.

Summary of the Compound Consonants—

Character.	*Name.*	*Letters.*	*As in*
	kwā	QU	**qu**ick, re**qu**est
	gwā	GU	**gu**ava, lin**gu**al
	hwā	WH	**wh**ere, every-**where**
(up)	wel	WL	**wel**l, un**well**
(up)	hwel	WHL	**whal**e, mean-**while**
(down)	ler	LR	fee**ler**, scho**larly**
(down)	rer	RR	poo**rer**, sha**rer**
	emp / emb	MP, MB	**camp**, **emb**alm

The following examples including small and large initial hooks should receive attention from the student—

clap, *equip*; *angle*, *penguin*; *wipe*, *whip*; *declare*, *require*, *enclose*, *inquest*, *local*, *loquacity*.

The student should note the following outlines as they are very important—

anywhere and *nowhere*; *queer* to distinguish from *clear*.

Exercise 42

GRAMMALOGUES

whether, *whither*; *will*; *while*.

1.
2.
3.
4.
5.
6.
7.
8.

Exercise 43

GRAMMALOGUES

important-ce, *improve-d-ment*; *impossible*, *improvements*.

1. quack, squire, quicker, quicken, quickly, quickest.
2. Paraguay, ware, where, whir, wherry, weary.
3. woolly, Wholley, whiskey, whistler, wail, whale.
4. caviller, chancellor, scorer, explorer, bearer, ruler.
5. Many *improvements in-the house* were *very* welcome.
6. *The importance of-the* invention *is* worthy *of* consideration.
7. *It-is almost impossible to-believe* such *improvements have*-taken place.
8. *The improved* sales *during* March *are very cheer*ing.

From the wall painting by W. F. Jeames, R.A., in the Royal Exchange.

THE FOUNDING OF ST. PAUL'S SCHOOL, 1509.

Dean Colet, the founder, receiving the royal license from King Henry VIII. The school was transferred to West Kensington from St. Paul's Churchyard in 1884.

Continued from page 191

ENGLISH LANGUAGE AND LITERATURE:

***Contributors*:**—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

EIGHTEENTH CENTURY POETS.—I

THE English literature of the eighteenth century between the days of Pope and of Wordsworth cannot be called great, but it was developing all the while into new forms, and so is varied and interesting.

Its one superlative addition to the nation's stock of books is the novel; but the growth of fiction from Richardson, through Fielding, Smollett, Goldsmith, and Fanny Burney, to Jane Austen, Scott, and other nineteenth century tale-tellers, is so important that it must be traced in a separate chapter.

Even while Pope was in the hey-day of his popularity, a departure from his types of subject and methods of poetical treatment had been made by the Scottish poet James Thomson, who took his readers from "the town" to the country, and from the formal rhyming couplet of the so-called classical school to blank verse. Poetical freedom was enlarging its bounds constantly during the rest of the century, through the writings of Collins, Gray, Goldsmith—who followed Pope in form, but not in spirit—Cowper, and Burns.

A Romantic Revival

In prose, History began to take a more concentrated and readable form in the hands of Hume, though still there was a great deficiency in research; but both research and style were satisfied in the labours and the monumental dignity of Gibbon. Man, as he had been studied by Pope—that is, as a philosophical abstraction, to be known through his systems of morals and his intellectual and social antics—declined in interest, but the every-day life of the common world became the theme of Gray, of Goldsmith, even of Johnson, still more of Cowper, and wholly of Crabbe, while that common life itself found its simplest expression in Robert Burns.

As the century progressed men's thoughts turned from the tame and measured literary fashions of its first decades to the far earlier poetry which sprang naturally from more romantic ages, and ancient ballads were popularised afresh by Bishop Percy's *Ancient Reliques*. This reversion to the past gave scope for a pretended revival of the more ancient poetry of the island in Macpherson's *Ossian*.

Samuel Johnson

Meantime, criticism, which had been placed on a firm footing in a general way by Dryden and by Pope, in furtherance of French ideals, was made more real by being applied to individual authors, as in Johnson's *Lives of the Poets* and Wharton's *History of English Poetry*. Biography, already developed in succinct memoirs, was brought suddenly to its highest success in Boswell's fond pages. Autobiography also reached its high-water mark in Gibbon's story of his life, published much later.

The drama had a brilliant revival in the sparkling comedy of Goldsmith and Sheridan. Theological argument became condensed and popularised for study in the works of Bishop Butler and Archdeacon Paley. The essay, which had turned social trifles into something approaching literature, in the earlier part of the century, was expanded by Goldsmith and Hume. Nature, so long forgotten by bookmen absorbed in town life, was again loved and pictured, in poetry by Cowper and Burns, and in prose by her ardent observer Gilbert White. And even Politics began to add its quota to pure literature in the finely-poised writings of Edmund Burke; while economics made a bid for a place through the reasoning of Adam Smith.

As all these developments proceeded simultaneously with the establishment of a standard type of fiction, it must be admitted that the literature of the later eighteenth century, though it has varied interest, falls short of notable power. But, while it sends to us much charming writing by Fielding, Sterne, Fanny Burney, Goldsmith, Boswell, Gray, Sheridan, and Cowper, among its authors there is only one really great man—Samuel Johnson ; and he was great as a personality rather than as a writer. He was the permanently typical John Bull, who, by chance, found a pen in his hand.

Glancing first at the verse of the period, we see that Edward Young (1683–1765), a discontented clergyman of Wessex birth, was the most widely popular poet in the middle of the eighteenth century. At the age of fifty-nine he wrote, in blank verse, a poem, entitled *Night Thoughts*, which was long read in English religious circles and freely circulated on the Continent. Having failed in writing bombastic rhetoric for the stage, Young gained some success as a satirist, and by fulsome flattery secured private and State pensions. He joined the Church in middle life, but never secured the promotion which he regarded as his due. The *Night Thoughts* has no plan or sequence, but it contains isolated passages of considerable power, marked by a gloomy intensity, and a condensation that makes them quotable. Here is an illustration of its style :

The bell strikes one. We take no note of time
But from its loss ; to give it then a tongue
Is wise in man. As if an angel spoke
I feel the solemn sound. If heard aright
It is the knell of my departed hours.
Where are they ? With the years beyond the flood.
It is the signal that demands despatch.

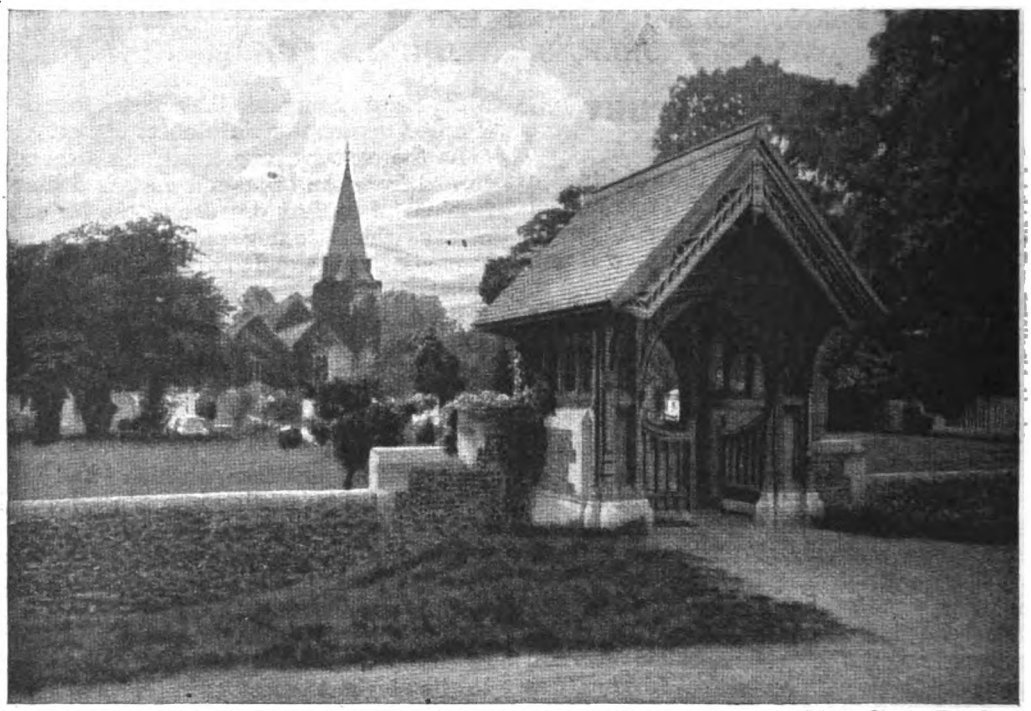


Photo : Chester Vaughan.

STOKE POGES CHURCHYARD,

near Windsor, where Thomas Gray planned his incomparable *Elegy*, and where he was buried beside the beloved mother whom he " had the misfortune to survive."

Young's sententious style lends itself to proverb-like quotation, as in " Procrastination is the thief of time " and " All men think all men mortal but themselves."

Samuel Johnson, who had essentially a masculine prose mind, published two poems —*London*, in 1738, and *The Vanity of Human Wishes*, in 1749, imitations of Juvenal's third and tenth satires. His too-mechanical tragedy *Irene*, written early, was acted in 1749. As a contemporary critic said, Johnson " put good sense into good metre." The chief interest in his verse is the references to his own career, which were true when they were written, but became less true through his influence in raising authorship from its discredited position.

Deign on the passing world to turn thine eyes,
And pause awhile from letters to be wise;
There mark what ills the scholar's life assail,
Toil, envy, want, the patron, and the gaol."

Thomas Gray (1716–1771) was the most characteristic poet during the generation

From the portrait by Benjamin Wilson, at Pembroke College, Cambridge.

THOMAS GRAY (1716-71),
whose *Elegy Written in a Country Churchyard* is one of the gems of English literature.

immediately following the death of Pope. He was a scholar and a recluse, without any ambition beyond perfecting his limited output of verse. His poems reflected the quietness of his life.

His first published poem (1747) was an *Ode on the Distant Prospect of Eton College*, where he had been educated; and, later, his *Ode for Music* chanted the glories of Cambridge, where he became a non-lecturing professor. By the use of the Ode he helped to reintroduce a flexibility that English verse had been losing under Pope. Gray's workmanship as a lyrical writer reached its most perfect form in his *Pindaric Odes*, as witness his etching of Shakespeare in *The Progress of Poesy*.

Far from the sun and summer glade,
In thy green lap was Nature's darling laid,
What time, where lucid Avon strayed,
To him the mighty mother did unveil
Her awful face: the dauntless child
Stretched forth his little arms and smiled.
"This pencil take," she said, "whose colours clear
Richly paint the vernal year:
Thine, too, these golden keys, immortal boy!
This can unlock the gates of Joy;
If Horror that, and thrilling tears,
Or ope the sacred source of sympathetic Tears."

It will be noted that Gray's first thought of Shakespeare is as a painter of Nature, and to Gray himself must be given the credit of being a pioneer in appreciation of the beauty and sublimity of Nature's grandest scenic displays. With Horace Walpole as a companion, he went to Switzerland to view the Alps, and his letters from thence, and also from the midst of impressive scenery at home, such as that of the Lake District, show him as an entranced lover of the beauty and wildness of the mountains.

Of a journey up the Grand Chartreuse he said, "not a precipice, not a torrent, not a cliff but is pregnant with religion and poetry. I do not remember to have gone ten paces without an exclamation that there was no restraining." This was written at a time when it was a fashion to regard mountain scenery as "barbarous." Gray's imaginative

From the portrait by Sir Joshua Reynolds, by permission of Lord Sackville.

OLIVER GOLDSMITH (1728-74).
Poet, playwright, novelist, essayist; his balanced union of literary gifts is almost unique.

experience was altogether beyond realisation by such a representative man of the eighteenth century as Samuel Johnson. The poet's range of taste in literature was equally wide, and included early Celtic and Norse romances.

Gray's immortality is secured by his *Elegy written in a Country Churchyard.* It was planned, doubtless, in Stoke Poges Churchyard, near Windsor, where Gray lies beside the beloved mother whom, as he said in her epitaph, he "had the misfortune to survive." Fastidious criticism, bent on destruction, has attacked the Elegy at every point, following the want of appreciation shown in the Johnsonian circle, where Gray was regarded with resentful jealousy; but it retains its place as one of the gems of our literature, a poem with a universal appeal because it expresses in nobly-toned verse a mood which comes to all men when, at the day's eventide, the eventide of life is harmoniously remembered.

William Collins

William Collins (1721–1759) was born in Sussex, educated at Winchester and Oxford, and after a literary life in London lost his mind in his thirtieth year. The *Odes*, which, by their "lone vesper chime," rank him among the choicest poets of his century, were published in his twenty-fifth year. His own generation plunged him in despair by its want of appreciation; but his *Ode on the Passions*, written for music, his *Evening*, and his suggested *Dirge in "Cymbeline"* will always keep his memory green. The most exquisite of all is the Ode commemorating those who fell in the Battle of Culloden in 1745:

How sleep the brave who sink to rest,
With all their country's wishes blest!
When Spring, with dewy fingers cold,
Returns to dress their hallowed mould,
She there shall dress a sweeter sod
Than Fancy's feet have ever trod.
By fairy hands their knell is rung,
By forms unseen their dirge is sung;
There Honour comes, a pilgrim gray,
To bless the turf that wraps their clay,
And Freedom shall a while repair,
To dwell, a weeping hermit, there!

The versatility of Oliver Goldsmith was such that some would hesitate whether to give pride of place to his poetry, or his plays, or his immortal *Vicar of Wakefield* and other prose writings. Johnson's Latin epitaph on his monument in Westminster Abbey, "*Nullum quod tetigit non ornavit*" ("he touched nothing that he did not adorn"), is as true as it is elegant. As poet, or playwright, or novelist, or essayist, Goldsmith must long have remained known, for he excelled in each form of writing, while his balanced union of literary gifts is almost unique.

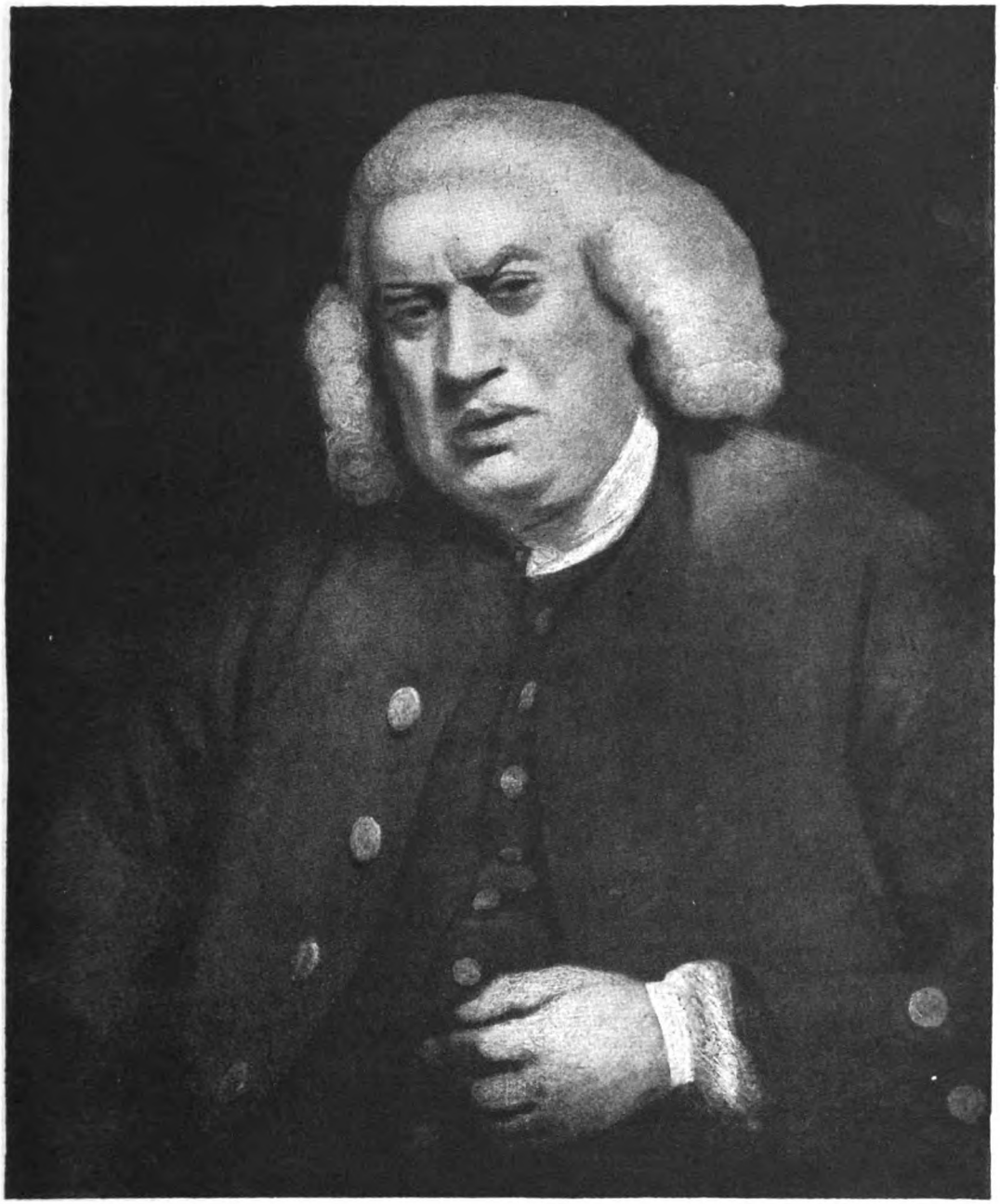
His charm—and, indeed, wisdom—as a writer contrast strangely with his futility in all practical affairs. He has suffered some disadvantage through being pictured for us by men who felt scant sympathy with him. Boswell, the enthusiastic architect of Johnson's fame, was, on behalf of his hero, intensely jealous of Goldsmith, and seized every opportunity of depreciating him. And, indeed, Goldsmith, throughout his whole life, was feckless beyond the verge of folly. He had in excess every fault of the careless Irishman; but he also had Irish lovableness, and no one can know his life and his work without feeling for him a tenderness as human and personal as any of the friendships that may be formed through books.

The son of a clergyman of English descent, whom he pictured in the *Deserted Village* and the *Vicar of Wakefield*, Goldsmith was born in Central Ireland in 1728, the exact place being unknown. Till his thirtieth year he was a roving ne'er-do-well. Educated in a desultory way at Dublin, Edinburgh, and during a wandering life on the Continent never fully traced, he failed to get a footing in the Church, the legal profession, and as a doctor, though he claimed to have secured a medical degree abroad. When he came back from his travels he served as an apothecary's assistant, and more than once as an usher in a school, and he only became a writer to escape these uncongenial duties.

Oliver Goldsmith

Writing was with him an afterthought; but he soon discovered his latent powers, and thereafter made clearly in his own mind a sharp division between the prose hackwork on which he became engaged by arrangement with the booksellers, and the works which expressed his long-thought-out theories, and gave scope to his literary ambition. His histories, criticisms, and popularisations of knowledge have perished. They were fluent and graceful but untrustworthy compendiums. But his lightly-thrown-off essays retain their charm, as in his *Citizen of the World* papers; his one story, the *Vicar of Wakefield*, though absurdly, planned, remains immortal; and his plays, *The Good-Natured Man* and *She Stoops to Conquer*, were the best of the age, and still hold the stage; while his poems, *The Traveller* and *The Deserted Village*, are accepted as a true form of poetry alike by the average reader and the critic.

The secrets of Goldsmith's charm are that he wrote simply, lucidly, easily, out of his



DR. SAMUEL JOHNSON (1709–84),

the outstanding literary figure of the eighteenth century, was a great personality rather than a great writer. He was a permanently typical John Bull, who by chance found a pen in his hand.

experiences, dominated by the human interest of the world. His eye singled out phases of character that have a lasting attraction, and he enjoyed them with humour, tenderness, and toleration. That toleration extended to his own weaknesses, which he regarded with a kind of amused interest. Though he was fond of an argument, and, as Johnson said of him, "disputed his way through Europe," his philosophy was never expressed in the airy nothings of verbal jugglery, but was based on the actualities of men's daily lives.

And it was a sounder philosophy than pseudo-science and pseudo-economy have been inclined to allow. The ages which have glorified the getting of wealth as the supreme practical end of human endeavour have pooh-poohed his praise of a simple life, and a "back to the land" policy, but the world is more and more inclined to think that he may have been right when he laid down his oft-repeated rule—

> Ill fares the land, to hastening ills a prey,
> Where wealth accumulates and men decay,

and his theory, in *The Traveller*, that each country has its own simple, natural, indigenous pleasures and rewards, inadequately understood by the stranger, has much to recommend it to people who have a personal knowledge of foreign lands.

The Deserted Village

Many writers much admired in their day are now forgotten because they made reading difficult for posterity, who will not be pestered by their obscurities. Goldsmith lives because he made reading easy by his spontaneous grace, his artless sentiment, humour, and faithful human portraiture.

For an example of his descriptive vein we give from *The Deserted Village* the pen picture of the now abandoned rural inn.

> Near yonder thorn, that lifts its head on high,
> Where once the sign-post caught the passing eye,
> Low lies that house where nut-brown draughts inspired,
> Where grey-beard mirth and smiling toil retired,
> Where village statesmen talked with looks profound,
> And news much older than their ale went round.
> Imagination fondly stoops to trace
> The parlour splendours of that festive place;
> The white-washed walls, the nicely sanded floor,
> The varnished clock that clicked behind the door;
> The chest contrived a double debt to pay,
> A bed by night, a chest of drawers by day:
> The pictures placed for adornment and use,
> The twelve good rules, the royal game of goose;
> The hearth, except when winter chilled the day
> With aspen boughs, and flowers, and fennel gay; . . .

J. D.

THE ENGLISH LANGUAGE.—XII

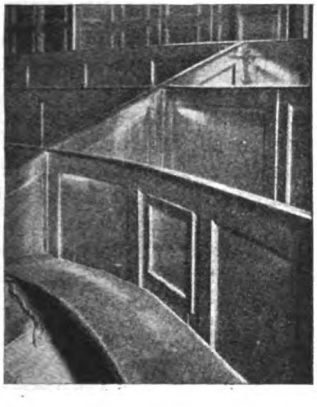
We turn finally to the essay, which is perhaps the most pleasurable form of composition. In each of the foregoing types the writer has a definite aim in view; but the essay is, as Dr. Johnson defined it, "a loose sally of the mind," in which the writer allows his mind to expatiate and wander round and about a subject which interests him and, by the pleasant manner of his treatment, delights his reader equally. There is a kind of comradeship between the essay-writer and his readers, as of a companion who takes us for a country ramble, and is able to fill the walk with the anecdotes, experiences and observations of a well-stored mind. We do not mind how far we go, or where we go, or by what route: it is the entertainment that arises by the way that we value. So it is with the essayist.

Essay-Writing

The title of the essay merely rings the bell for him: the rest is the expression of his own personality, the revelation of his own idiosyncrasies which are found to be all of delightful interest. Addison, Goldsmith and Lamb are the models most congenial to this conception of the essay.

The themes upon which such essays can be satisfactorily written are as varied as human interests themselves. They range from the humorous character-sketch to grave reflections upon some exalted moral subject, from tender recollections to wide-sweeping speculations. They may be business-like and practical in intention, like most of Bacon's, rich with the winnowed garnerings of a man of the world's experience; or they may be wise and gracious meditations upon the various phases of life and character, pointed by pregnant observation and tolerant good sense, like Montaigne's. They may be ironic satires of contemporary society, in a spirit of kindly humour, clothed in limpid and artless English, like Addison's; or, again, they may be lit up with those gleams of wit and pathos, that peculiar strain of humane and allusive humour that we find in the *Essays of Elia*.

Or, leaving the men of genius, we might find a model in the discursive interests of Leigh Hunt or in the unobtrusive courage of Stevenson. Wherever we find our inspiration, it is in our own hearts—in our own experiences and observations—that we shall find our material and our method. For, even in the most admired discourse, there must be a clue to thought.



DR. JOHNSON AT HOME.

1. The house in which Dr. Johnson was born, at Lichfield; 2. his chair, now at the Ladies' Charity School, Bayswater; 3. the house where Johnson and Boswell first met, in Russell Street, Covent Garden; 4. Dr. Johnson's house in Gough Square, Fleet Street; 5. his pew in the gallery of St. Clement Danes Church; and 6, his room in the "Cheshire Cheese," Fleet Street. Inset is a portrait of his biographer, James Boswell.

There must be nothing clumsy or incongruous, no mere intrusions and interlopings. A pleasing personality does not reveal itself in erratic eccentricities, nor in mere tumblings and jugglings of ideas ; nor does it shine amid grammatical chaos or in the tangle of inextricable threads of thought. Method there must be then, and unity, even with the liberty that the essay-idea allows. An unexpected hiatus, anything that rubs or jars, whatever produces friction or antipathy in the reader's mind, is fatal. An essay is the writer's best talk, set forth with an attractive garnish, in the best taste and style that he can muster.

Magazines and Reviews

During the last hundred years the use of the word essay has widened until it has a far greater scope than is implied in Johnson's definition. It connotes now any kind of disquisition, even an exhaustive analysis or criticism, on any subject of general interest. This result may be ascribed to the success of the great magazines and reviews which offered, and still offer, a convenient platform for the discussion of almost any subject. Some of the best work of De Quincey and Macaulay, of Carlyle and Huxley, for example, has taken this form. The mention of these names reminds us of the variety of subject that has come into the domain of the essay.

Literary criticism and science, history and economics, politics and religion—every conceivable subject indeed—has received the hospitality of the reviews. The type of composition thus produced is much more severe and formal than the essay proper. Within its own limits it must be complete ; inasmuch as it relies upon logic and argument in the main, it demands careful organisation and selection of matter, and a style which aims rather at lucidity and power than at grace and imaginative pleasure.

Careful preparation is necessary both for the mastery of the facts and for their suitable and effective use. The resultant essay will contain the cream of the writer's thought upon a theme which he has perfectly assimilated. All attempts to write it upon a basis of imperfect knowledge or of ideas not fully worked out to their logical conclusion are certain to fail. This remark applies, almost without qualification, to all essays on historical or political, social or political themes.

Literary criticism, however, may cover a wider extent of ground, as we gather clearly when we mention together the literary criticism of such men as Hazlitt, Carlyle and Matthew Arnold. But in all these cases, whatever the method employed—be it biographical, analytical or impressionist—the central aim is always appreciation, not condemnation. The critic is not simply a severe judge, testing his author by the touchstone of irrefragable laws. He is rather the sympathetic expositor who has found a special clue to his author's meaning. Carlyle's essay on Burns and Matthew Arnold's essay on Wordsworth are, in their different ways, most admirable examples of the spirit in which great writers should be approached by those who would write about them.

The most difficult and the loftiest form of composition—that which forms the basis of poetry—is the writing of verse. Verse adds to the requirements of prose the claims of metre. Poetry calls for something higher, however, than a skilful making of verses, which is an art to be acquired, like any other form of composition, by any one who will take the trouble. But great prose is in this respect not different from poetry : its secrets are incommunicable. Its qualities —of imagination, vision, cadence, magic— are the private idiosyncrasies of the man of genius. The phrase which charms, the rhythmic movement that captivates, the word that opens a world—these can be felt and admired ; but the key to their making, whether in prose or in verse, is not in the possession of the mere teacher or of the average writer.

Metre

Metre means the regular recurrence of a particular rhythm, according to some definite scheme which the writer has imposed upon himself. The fundamentals of metre are the **line** of verse which in its turn breaks up into *feet*. The number of feet in the line defines the metre as *dimeter*, *trimeter*, etc. ; the *pentameter* or line of five feet is perhaps the most familiar type in English poetry.

The commonest foot is known as an **iambus,** in which an unaccented syllable is followed by an accented one as in the word, *admit* (˘ ′); e.g.—

O, tén/der spoúse / of góld / Hypér/ión !
(Iambic Pentameter.)

A sóft / and lúll/ing soúnd / is heárd. (Iambic Tetrameter.)

In the **trochee** we have these conditions reversed ; an accented syllable is followed by an unaccented, as in the word *comrade* (′ ˘); e.g.—

Lóng they / lived in / peáce to / géther. (Trochaic Tetrameter.)

The **anapæst** has two unaccented syllables followed by an accented one ; e.g.—

And the sheén / of their speárs / was like stárs / on the séa. (Anapæstic Tetrameter.)

The **dactyl** is the reverse of the anapæst ; e.g.—

Táke her up / ténderly. (Dactylic dimeter.)

The **amphibrach** is a three-syllabled foot in which the middle syllable has the chief weight, as in *precisely* (˘ ´ ˘) ; e.g.—

And nów they / are moáning / on ílka / green loáning. (Amphibrachic tetrameter.)

While a poet generally adheres to the regular laws of his metre, some of his most pleasing effects are obtained from variations or irregularities in his scheme. Thus, a trochee or anapæst may be introduced into iambic metre, a dactyl may be shortened to a trochee, and so on. Or, on the other hand, a line may contain a syllable more or less than is required by th exact metre. Among such variations we may also include variation in the position of the pause or **cæsura,** which does not fall always or even generally at the end of a line, as any passage from Shakespeare or Milton will show.

Cadence and Rhythm

Variety of cadence and rhythm thus introduced add very much to the emotional quality of verse. The musical effect is also heightened by suitable variations in the strength of the accent, even when the strict metre is preserved. Other devices are those of **elision** and **onomatopœia.** In the first, two short syllables are run as it were into one, or sometimes overlapping vowels are fused together so that two words blend into one ; e.g.—

The applause / of list/ening sen/ates to / command.

Onomatopœia means the attempt to render the sense through the sound of the words used, as in Tennyson's well-known lines in *The Princess* :—

Myriads of rivulets hurrying through the lawn,
The moan of doves in immemorial elms
And murmur of innumerable bees.

Lines of verse may be grouped together in **stanzas,** rimed according to some simple or complex scheme. It is impossible to detail here the many kinds of stanza employed by English poets ; they are very numerous, as a glance at any anthology will show ; but the student's attention is drawn to the stanzas of *The Ancient Mariner*, Gray's *Elegy*, *The Faerie Queene*, *Don Juan*, Chaucer's *Clerk's Tale* and *In Memoriam* for examples of some of the most familiar. More elaborate stanzaic schemes can be found frequently, among the poems of Swinburne especially. The sonnet may be regarded as a stanza which forms a complete poem in itself : compare, however, the sonnet sequence of Shakespeare with the single sonnets of Milton, Wordsworth or Keats, noticing at the same time their rime arrangements.

Continuous verse may be rimed also, as in the satires of Dryden and Pope, which are in heroic couplets, i.e. iambic pentameters riming in successive pairs. Other examples of heroic couplets, employed in narrative poetry, are Marlowe's *Hero and Leander* and Swinburne's *Tristram in Lyonnesse*. Scott's poems and Wordsworth's *White Doe of Rylstone* are examples of riming verse in iambic tetrameters.

Verse which does not rime is called **blank verse.** The most familiar, and at the same time the grandest and loftiest, metre in English poetry, is the heroic blank verse of Shakespeare, Milton, Wordsworth, Shelley, Tennyson, Browning, etc. ; in which each line is an iambic pentameter, varied into every modulation of rhythm, and capable of expressing the sublimest meditations and the most dramatic characters in our literature.

Exercises

1. Write on *one* of the following themes :—Personality ; Modesty ; Freedom ; Friendship ; Asceticism ; Solitude ; Nature ; Pleasure ; Immortality.

2. *One* of the following :—Modern Amusements ; The Uses of Books ; The Decay of Nations ; Man and the Birds ; Adventure as an End in Life ; Our National Army.

3. *One* of the following :—A Great Banquet ; A Lord-Mayor's Show ; The Art-Critic ; The Daily Newspaper ; The Superman ; A Flying-man's Fancy ; The Pessimist ; Ghosts.

4. *One* of the following :—" Old Age hath yet its honour and its toil " ; " The best laid schemes of mice and men gang aft agley " ; " We are such stuff as dreams are made of."

5. *One* of the following. (*Historical*) : — The Work of the Catholic Church in Europe ; The Renaissance ; Columbus ; Luther ; Queen Elizabeth ; The Puritans ; The French Revolution ; The English in India ; The Growth of our present Industrial System ; The Union of Germany ; The Problem of the Turkish Empire ; The Russian Revolution ; America and Europe ; Feudalism and its Modern Survivals ; Mazzini.

6. *One* of the following. (*Literary*) :—The Influence of Greek Literature ; Epic Poetry in England ; Hamlet ; The Function of Poetry ; The Drama in France ; Romance in Poetry ; Wordsworth as the Poet of Nature ; Contrast between Shelley and Keats ; Scott ; Dickens ; Tennyson ; The Novel in the last twenty years.

E. W. E.

Continued from page 198.

HISTORY:

Contributors:—J. A. Brendon, B.A.(Oxon.), F.R.Hist.S.; F. Collinson, F.R.Hist.S.; T. P. Evans, B.A.(Oxon.); James A. Manson; L. Stampa, M.A.(Oxon.); and J. B. Sterndale-Bennett.

BRITAIN'S STORY.—VII

[*The introductory chapter of* LORD MACAULAY'S "*History of England*" *has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages* (*printed in closer type*) *have been interpolated in order to meet the requirements of the student.*]

AFTER the wars of York and Lancaster, the links which connected the nobility and the commonalty became closer and more numerous than ever.

The extent of the destruction which had fallen on the old aristocracy may be inferred from a single circumstance. In the year 1451 Henry VI. summoned fifty-three temporal Lords to parliament. The temporal Lords summoned by Henry VII. to the parliament of 1485 were only twenty-nine, and of these several had recently been elevated to the peerage.

Lords and Commons

During the following century the ranks of the nobility were largely recruited from among the gentry. The constitution of the House of Commons tended greatly to promote the salutary intermixture of classes. The knight of the shire was the connecting link between the baron and the shopkeeper. On the same benches on which sat the goldsmiths, drapers, and grocers, who had been returned to parliament by the commercial towns, sat also members who, in any other country, would have been called noblemen. Some of them were younger sons and brothers of lords. Others could boast of even royal blood.

At length the eldest son of an Earl of Bedford, called in courtesy by the second title of his father, offered himself as candidate for a seat in the House of Commons, and his example was followed by others. Seated in that house, the heirs of the great peers naturally became as zealous for its privileges as any of the humble burgesses with whom they were mingled.

Thus our democracy was, from an early period, the most aristocratic, and our aristocracy the most democratic in the world; a peculiarity which has lasted down to the present day, and which has produced many important moral and political effects.

Tudor Pretensions

The government of Henry VII., of his son, and of his grandchildren was, on the whole, more arbitrary than that of the Plantagenets. Personal character may in some degree explain the difference; for courage and force of will were common to all the men and women of the House of Tudor. They exercised their power during a period of a hundred and twenty years, always with vigour, often with violence, sometimes with cruelty.

They, in imitation of the dynasty which had preceded them, occasionally invaded the rights of the subject, occasionally exacted taxes under the name of loans and gifts, and occasionally dispensed with penal statutes: nay, though they never presumed to enact any permanent law by their own authority, they occasionally took upon themselves, when Parliament was not sitting, to meet temporary exigencies by temporary edicts. It was, however, impossible for the Tudors to carry oppression beyond a certain point: for they had no armed force, and they were surrounded by an armed people. Their palace was guarded by a few domestics, whom the array of a single shire, or of a single ward of London, could with ease have overpowered.

These haughty princes were therefore under a restraint stronger than any which mere law can impose, under a restraint which did not, indeed, prevent them from sometimes treating an individual in an arbitrary and even in a barbarous manner, but which effectually secured the nation against general and long continued oppres-

sion. They might safely be tyrants within the precinct of the court: but it was necessary for them to watch with constant anxiety the temper of the country. Henry VIII., for example, encountered no opposition when he wished to send Buckingham and Surrey, Anne Boleyn and Lady Salisbury, to the scaffold. But when, without the consent of Parliament, he demanded of his subjects a contribution amounting to one-sixth of their goods, he soon found it necessary to retract.

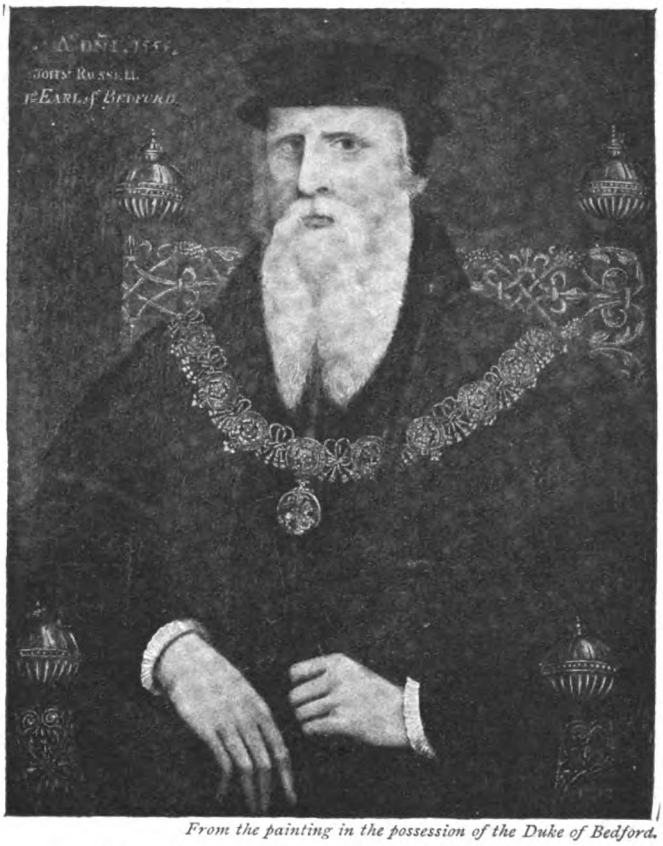
The cry of hundreds of thousands was that they were English and not French, freemen and not slaves. In Kent the royal commissioners fled for their lives. In Suffolk four thousand men appeared in arms. The King's lieutenants in that county vainly exerted themselves to raise an army. Those who did not join in the insurrection declared that they would not fight against their brethren in such a quarrel. Henry, proud and self-willed as he was, shrank, not without reason, from a conflict with the roused spirit of the nation. He had before his eyes the fate of his predecessors who had perished at Berkeley and Pomfret. He not only cancelled his illegal commissions; he not only granted a general pardon to all the malcontents; but he publicly and solemnly apologised for his infraction of the laws.

His conduct, on this occasion, well illustrates the whole policy of his house. The temper of the princes of that line was hot, and their spirit high; but they understood the character of the nation which they governed, and never once, like some of their predecessors, and some of their successors, carried obstinacy to a fatal point. The discretion of the Tudors was such that their power, though it was often resisted, was never subverted.

The reign of every one of them was disturbed by formidable discontents; but the government was always able either to soothe the mutineers, or to conquer and punish them. Sometimes, by timely concessions, it succeeded in averting civil hostilities; but in general it stood firm, and called for help on the nation. The nation obeyed the call, and rallied round the sovereign.

Thus, from the age of Henry III. to the age of Elizabeth, England grew and flourished under a polity which contained the germ of our present institutions.

But such a polity is suited only to a particular stage in the progress of society. The same causes which produce a division of labour in the peaceful arts must at length make war a distinct science and a distinct trade. A time arrives when the use of arms begins to occupy the entire attention of a separate class. It soon appears that peasants and burghers, however brave, are unable to stand their ground against veteran soldiers, whose whole life is a preparation for the day of battle. It is found that the defence of nations can no longer be safely entrusted to warriors taken from the plough or the loom for a campaign of forty days.



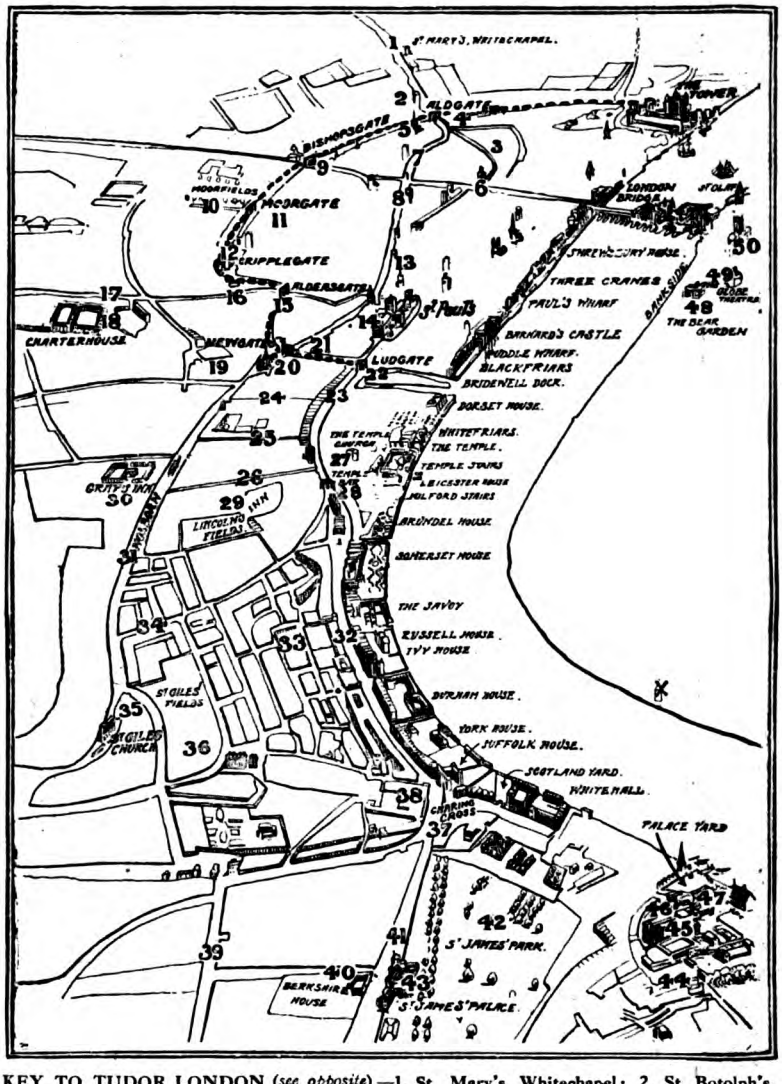
From the painting in the possession of the Duke of Bedford.

JOHN RUSSELL, FIRST EARL OF BEDFORD.

Typical of the nobility recruited by the Tudors from among the gentry. His only son, Francis Russell, sat as M.P. for Buckinghamshire from 1547-52, and was the first heir to a peerage to offer himself for election to the House of Commons.

But where a great regular army exists, limited monarchy, such as it was in the Middle Ages, can exist no longer. The sovereign is at once emancipated from what had been the chief restraint on his power; and he inevitably becomes absolute, unless he is subjected to checks such as would be superfluous in a society where all are soldiers occasionally, and none permanently.

With the danger came also the means of escape. In the monarchies of the Middle Ages the power of the sword belonged to the prince; but the power of the purse belonged to the nation; and the progress of civilisation, as it made the sword of the prince more and more formidable to the nation, made the purse of the nation more and more necessary to the prince. His hereditary revenues would no longer suffice, even for the expenses of civil government. It was utterly impossible that, without a regular and extensive system of taxation, he could keep in constant efficiency a great body of disciplined troops.



KEY TO TUDOR LONDON (*see opposite*).—1. St. Mary's, Whitechapel; 2. St. Botolph's, Aldgate; 3. Fenchurch St.; 4. Aldgate; 5. St. James's Church; 6. Gracechurch St.; 7. Leadenhall St.; 8. Cornhill; 9. Bishopsgate; 10. Moorfields; 11. Moorgate; 12. Cripplegate; 13. Cheapside; 14. St. Paul's; 15. Aldersgate; 16 & 17. Aldersgate St.; 18. Charterhouse; 19. Smithfield; 20. St. Sepulchre's Church; 21. Newgate; 22. Ludgate; 23. Fleet St.; 24. Shoe Lane; 25 Fetter Lane; 26. Chancery Lane; 27. Temple Church; 28. Temple Bar; 29. Lincoln's Inn Fields; 30. Gray's Inn; 31. Holborn; 32. Strand; 33. Covent Garden; 34. Drury Lane; 35 & 36. St. Giles's Church and Fields; 37. Charing Cross; 38. The Mews; 39. Knightsbridge to Piccadilly Hall; 40. Berkshire House; 41. Pall Mall; 42. St. James's Park; 43. St. James's Palace; 44. Dean's Yard; 45. Westminster Abbey; 46. Sanctuary; 47. Westminster Palace; 48. Bear Garden; 49. Globe Theatre; 50. St. Mary Overy.

The policy which the parliamentary assemblies of Europe ought to have adopted was to take their stand firmly on their constitutional right to give or withhold money, and resolutely to refuse funds for the support of armies, till ample securities had been provided against despotism. This wise policy was followed in our country alone. In the neighbouring kingdoms great military establishments were formed; no new safeguards for public liberty were devised; and the consequence was that the old parliamentary institutions everywhere ceased to exist.

In France, where they had always been feeble, they languished, and at length died of mere weakness.

One after another the great national councils of the continental monarchies, councils once scarcely less proud and powerful than those which sat at Westminster, sank into utter insignificance. If they met, they met merely as our Convocation now meets, to go through some venerable forms.

Drawn by Hugh Fisher.

TUDOR LONDON.

A retrospective bird's-eye view (*see key opposite*).

In England events took a different course. This singular felicity she owed chiefly to her insular situation. Before the end of the fifteenth century great military establishments were indispensable to the dignity, and even to the safety, of the French and Castilian monarchies. If either of those two powers had disarmed, it would soon have been compelled to submit to the dictation of the other. But England, protected by the sea against invasion, and rarely engaged in warlike operations on the Continent, was not, as yet, under the necessity of employing regular troops.

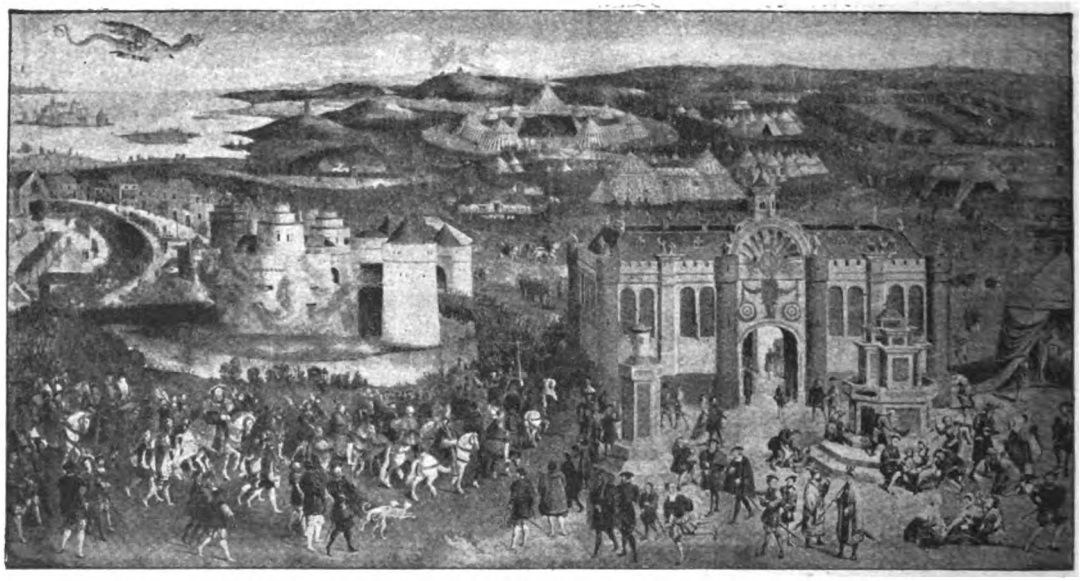
The sixteenth century, the seventeenth century, found her still without a standing army. At the commencement of the seventeenth century political science had made considerable progress. The fate of the Spanish Cortes and of the French States General had given solemn warning to our Parliaments; and our Parliaments, fully aware of the nature and magnitude of the danger, adopted, in good time, a system of tactics which, after a contest protracted through three generations, was at length successful.

Almost every writer who has treated of that contest has been desirous to show that his own party was the party which was struggling to preserve the old constitution unaltered. The truth, however, is that the old constitution could not be preserved unaltered.

A law, beyond the control of human wisdom, had decreed that there should no longer be governments of that peculiar class which, in the fourteenth and fifteenth centuries, had been common throughout Europe. The question, therefore, was not whether our polity should undergo a change, but what the nature of the change should be. The introduction of a new and mighty force had disturbed the old equilibrium, and had turned one limited monarchy after another into an absolute monarchy.

What had happened elsewhere would assuredly have happened here, unless the balance had been redressed by a great transfer of power from the crown to the Parliament. It seems certain, therefore, that, had none but political causes been at work, the seventeenth century would not have passed away without a fierce conflict between our Kings and their Parliaments. But other causes of perhaps greater potency contributed to produce the same effect.

While the government of the Tudors was in its highest vigour, an event took place which has coloured the destinies of all Christian nations, and in an especial manner the destinies of England.



HENRY VIII. ON HIS WAY TO THE FIELD OF THE CLOTH OF GOLD

on the Plain of Ardres, where the famous meeting took place (1520) between the King of England and the King of France, the latter, Francis I., hoping thereby to persuade Henry to support him in his struggle with the House of Hapsburg. This contemporary picture shows every incident with elaborate historical detail. The English cavalcade can be seen arriving on the left, with the King and Wolsey in the foreground.

Continued from page 215.

SCIENCES:

Contributors:—ANTHROPOLOGY AND ETHNOLOGY (Sir H. H. Johnston, G.C.M.G., K.C.B.). ASTRONOMY (Arthur R. Hinks, M.A., F.R.S.). BOTANY (E. W. Edmunds, M.A., B.Sc.[Lond.]). CHEMISTRY (E. H. Tripp, Ph.D.). ELECTRICITY AND MAGNETISM (L. M. Parsons, M.Sc., D.I.C., F.G.S.). GEOLOGY AND MINERALOGY (Arthur Holmes, D.Sc. [Lond.], A.R.C.S., D.I.C., F.G.S.). PHYSIOLOGY (Sir Malcolm Morris, K.C.V.O., and D. W. Carmalt-Jones, M.A., M.D.[Oxon.]). SOUND, LIGHT, AND HEAT (E. W. Edmunds, M.A., B.Sc. [Lond.]). ZOOLOGY (E. A. Bryant and Ashley G. Brown, F.Z.S.).

CHEMISTRY.—XXI

Oxides and Oxy-acids of Sulphur.—SULPHUR dioxide is a constituent of volcanic gases, and is also found in the air of towns, being produced by the oxidation of the iron pyrites present in coal. Whenever this mineral (and most other sulphides) is roasted, i.e. burnt, the contained sulphur is converted chiefly into sulphur dioxide, and the metal is left behind as oxide, $4FeS_2+11O_2=2Fe_2O_3+8SO_2$. This reaction does not afford a good laboratory method of preparing the gas; neither is it advisable to make it by burning sulphur in air, because it is then obtained mixed with much nitrogen. It is usually prepared by heating copper with strong sulphuric acid. $Cu+2H_2SO_4=CuSO_4+2H_2O+SO_2$. Other metals, e.g. iron, zinc, tin and silver may be used instead, and the non-metals, carbon and sulphur also reduce sulphuric acid. $C+2H_2SO_4=CO_2+2H_2O+2SO_2$; $S+2H_2SO_4=2H_2O+3SO_2$.

Experiment LXV.—*Preparation of Sulphur Dioxide from Sulphuric acid and Copper.*

(i) Copper turnings and a slight excess of sulphuric acid are heated together in the apparatus used for making hydrogen chloride (Experiment XXXIX., p. 135, Vol. II.), and the gas is collected by downward displacement, being about 2¼ times heavier than air. About six jars should be collected, and with these the student should investigate the behaviour of the gas towards a light, litmus, water, burning magnesium, and a coloured flower. He should discover for himself the properties enumerated below.

Sulphur dioxide is a colourless, heavy gas with a characteristic smell. It neither burns nor supports the combustion of ordinary combustibles, yet certain metals, e.g., potassium, magnesium, tin and finely-divided iron will burn in it. Water dissolves it with ease, at 0°, 1 volume of water dissolves 80 volumes, at 20°, 39·5 volumes. At —10° under ordinary pressure it is transformed into a colourless liquid which is sold commercially in siphons and used for bleaching, disinfecting and other purposes. The aqueous solution contains free sulphurous acid, H_2SO_3, which is only known in solution as it readily decomposes, $SO_2 + H_2O \leftrightarrows H_2SO_3$. Sulphurous anhydride behaves both as an oxidising and as a reducing agent. It oxidises those metals which burn in it; it converts lead peroxide into lead sulphate, $PbO_2+SO_2=PbSO_4$; and it reacts with hydrogen sulphide to form sulphur and water, $SO_2+2H_2S=3S+2H_2O$. Its reducing action is manifested in presence of water.

With nitric acid it forms sulphuric acid, oxides of nitrogen and water; with chlorine it yields sulphuric and hydrochloric acids. $H_2SO_3+H_2O+Cl_2=H_2SO_4+2HCl$, and on this account it is used to remove the last traces of chlorine from articles that have been bleached. Sulphur dioxide is an excellent bleacher itself, particularly for delicate goods, like silk, wool and straw which are attacked by chlorine.

The bleaching action is usually explained by the assumption that the "nascent" hydrogen liberated actually performs the bleaching by its reducing action, $H_2SO_3+H_2O=H_2SO_4+2H$. At the moment of liberation the hydrogen is believed to consist of free atoms, which theory indicates would be endowed with more free energy than the same atoms grouped together in the form of molecules. The colour can often be restored by treatment with alkali. Thus a blanket or a sponge bleached with sulphur dioxide is turned a very pale yellow, and on immersion in a soap solution, which contains free alkali, the original dark yellow or brown colour is restored.

Sulphurous acid is dibasic; it forms two series of salts with monovalent metals, e.g. normal sodium sulphite, Na_2SO_3, alkaline to litmus, and acid sodium sulphite, $NaHSO_3$, or bisulphite, neutral to litmus. All sulphites are decomposed by dilute acids yielding sulphur dioxide, which is detected by its smell, its action on litmus, and by its action on acidified solutions of potassium permanganate or potassium bichromate; permanganate is decolorised and bichromate turned green. Large quantities of calcium sulphite are used for washing out empty beer barrels, etc., and in the making of wine.

Sulphur Trioxide and Sulphuric Acid.—In addition to sulphur dioxide, sulphur also forms

another oxide, called sulphur trioxide or sulphuric anhydride, because it forms sulphuric acid with water, $SO_3+H_2O=H_2SO_4$. We have learnt that small quantities of this oxide are formed when sulphur is burnt in air or oxygen, and that they unite with atmospheric moisture to form a mist or fumes of sulphuric acid. The oxidation of sulphur dioxide to the trioxide takes place extremely slowly at the ordinary temperature, but the reaction proceeds quickly when pure sulphur dioxide and purified air or oxygen, mixed in the correct proportions, are passed over heated finely-divided platinum at a temperature of about 400°. The platinum acts as a catalyst; it accelerates the action without undergoing any permanent change itself. At temperatures above 400°, the trioxide is decomposed into the dioxide and oxygen,

$$\underset{4\text{ vols.}}{2\,SO_2} + \underset{2\text{ vols.}}{O_2} \rightleftarrows \underset{4\text{ vols.}}{2\,SO_3}.$$

Experiment LXVI.—*To oxidise Sulphur Dioxide to the Trioxide.*

Sulphur dioxide, obtained preferably from a siphon of the liquid, and oxygen are bubbled through sulphuric acid contained in a three-necked bottle and the mixture passed through a hard glass tube containing platinised asbestos (made by soaking asbestos fibre in platinum chloride solution and igniting), and which is gently heated by a burner. It

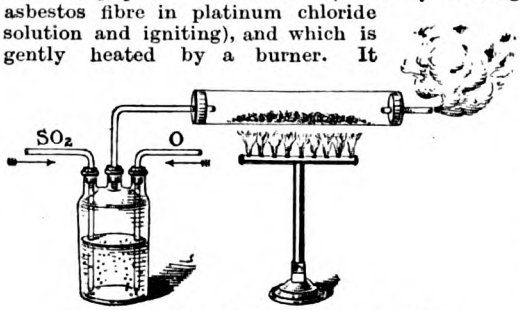


Fig. 33A.—To oxidise sulphur dioxide.

will be observed that although no gas or vapour is visible inside the apparatus, yet dense white fumes issue from the open end. These are fumes of sulphuric acid formed by the combination of the sulphuric trioxide with the moisture in the air. The trioxide may be obtained as a colourless liquid by passing it through a condensing tube immersed in a freezing mixture (cf. Experiment LI., Vol. III., p. 69), great care being taken that the inside of the whole apparatus is absolutely dry.

Liquid sulphur trioxide fumes in the air and crystallises in long needle-shaped crystals which melt at 14·8°. Another crystalline form, resembling asbestos in appearance but more lustrous, is obtained by keeping the liquid substance for some time at 16°; this form melts at 25°, and slowly changes into the first variety at temperatures between 50° and 100°. Thus sulphur trioxide is dimorphous (two shapes). Besides combining with water with great energy, it dissolves in sulphuric acid itself, forming Nordhausen or "fuming" sulphuric acid, which usually contains a mixture of acids of the types $H_2S_2O_7$ ($H_2SO_4 \cdot SO_3$), $H_2S_3O_{10}$($H_2SO_4 \cdot 2SO_3$), etc.

Sulphuric Acid or "oil of vitriol" is the most important of all manufactured chemicals, the yearly output running into millions of tons. There are few industries which do not require it, directly or indirectly, the most important being: washing soda and hydrochloric acid (hence, indirectly, chlorine), fertilisers (notably superphosphate), nitric acid, high explosives, dyes, phosphorus, organic acids, glucose, alum, copper sulphate and many other metallic sulphates. It is made by two distinct processes: (*a*) The Catalytic Process, and (*b*) The Lead Chamber Process.

(*a*) The principle of the modern catalytic method is that already described in Experiment LXV., viz. the oxidation of sulphur dioxide to trioxide by means of atmospheric oxygen. The gases are highly purified and then passed over heated finely-divided platinum. The resulting sulphur trioxide may be passed into water, but industrially it is absorbed in sulphuric acid of 97-98 per cent. strength, and in this form it is transported; when required for ordinary uses the fuming acid is diluted with water on the spot.

This process yields a very pure acid and scientifically it is wellnigh perfect, but for many purposes, where a very pure acid is not necessary, acid made by the older Lead Chamber Process is more economical. Many difficulties were encountered in working out the catalytic process, chief among which was the deterioration of the very expensive platinum catalyst, and this obstacle was not overcome for many years, not until it was discovered that the reacting gases contained "poisons," i.e. impurities which put the catalyst out of action, and which had to be eliminated in a most complete manner. The main reaction takes place in cylindrical, upright tubes containing shelves packed with platinised asbestos, and these vessels are enclosed in a chamber, every precaution being taken to keep the temperature below 400°; they are cooled by allowing the incoming sulphur dioxide and air to circulate round them.

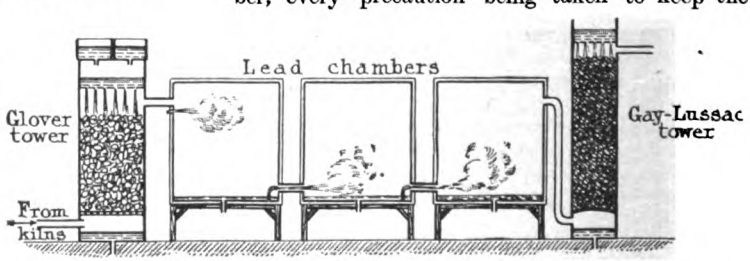


Fig. 34.—Making sulphuric acid by the Lead Chamber Process.

(*b*) In the method known as the Lead Chamber Process sulphur dioxide, in presence of water, is oxidised by means of nitrogen oxides, principally the peroxide. $SO_2+H_2O+O=H_2SO_4$. The nitrogen peroxide is reduced to nitric oxide, but the latter on coming in contact with air is re-converted into the peroxide, $2NO_2 \rightleftarrows 2NO+O_2$. This explanation is not strictly correct, the reactions which take place are many and complex, and it cannot be said that they are known with exactness. The sulphur

dioxide is produced by roasting iron pyrites, or by burning sulphur, in specially designed kilns, and this gas, together with air and oxides of nitrogen, generated initially by the action of the sulphur dioxide upon nitric acid vapour, and steam are passed into the leaden chamber. Usually two or three chambers joined in series are employed, and in them the main actions take place, resulting in the formation of a crude, weak sulphuric acid ("chamber" acid containing 62-70 per cent. of H_2SO_4) which collects upon the floor.

In order to avoid the loss of nitrogen oxides, the gases issuing from the chambers are passed upwards through the Gay-Lussac tower, where they meet and are absorbed by concentrated sulphuric acid trickling through coke. The nitrated acid formed in this tower is made to give up its nitrogen oxides to the sulphur dioxide and air coming from the pyrites kilns, by passing these gases up through a Glover tower, containing flints down through which the nitrated acid percolates. The tower is interposed between the kilns and the first lead chamber.

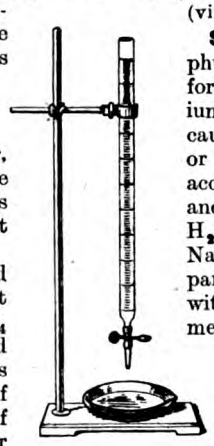


Fig. 35.—A Burette and Stand.

The chamber acid is then concentrated by evaporation in leaden pans until it contains about 79 per cent. of H_2SO_4 (when the lead begins to be attacked seriously), and the concentration of this acid, known as B.O.V. (brown oil of vitriol), is continued in stills made of glass, silica, or platinum. In this manner an acid containing about 98·3 per cent. H_2SO_4 is obtained. Should a 100 per cent. acid (mono-hydrate) be required, the oil of vitriol is cooled until colourless crystals of the anhydrous acid separate.

Properties.—Pure sulphuric acid is a colourless oily liquid of sp. gr. 1·84 which decomposes partially at its boiling point, 317°. $H_2SO_4 \rightleftarrows SO_3+H_2O$ When mixed with water a contraction in volume ensues, and much heat is evolved owing to the formation of definite hydrates. When sulphuric acid is diluted, the acid should always be added in small quantities to the water and not *vice versa*, otherwise a dangerous accident may take place. It is very hygroscopic, and is much used for drying gases, including the air in a desiccator. It also readily deprives many organic substances of the elements of water contained in them. Thus starch, wood and sugar are charred owing to the separation of carbon, their hydrogen and oxygen being taken away by the sulphuric acid. For a similar reason a crystal of copper sulphate is turned white.

As already mentioned many metals are attacked by hot sulphuric acid with the evolution of sulphur dioxide and the formation of a sulphate. When the cold dilute acid dissolves a metal, hydrogen and the metallic sulphate result. In these actions the sulphuric acid behaves as an oxidising agent.

Experiment LXVII.—*Properties of Sulphuric Acid.*

(i) A thermometer is put into a beaker containing cold water, and sulphuric acid is added: an appreciable rise in temperature takes place. (ii) Some acid is placed in a graduated cylinder and left exposed to the air for some days: the level of the liquid rises. (iii) Sulphuric acid is added to a warm concentrated solution of sugar contained in a beaker, there is a violent reaction, much heat is generated, steam and sulphur dioxide are evolved, and a black porous mass of carbon remains. (iv) A large crystal of copper sulphate is suspended in the acid; it loses its colour owing to dehydration. (v) A piece of firewood is charred when dipped into oil of vitriol. (vi) Small quantities of zinc, iron, tin and lead are heated in test tubes with the concentrated acid: the metals are attacked and, except in the case of lead, the sulphates formed remained dissolved. (vii) Sulphuric acid turns litmus red.

Sulphates.—The dibasic nature of sulphuric acid follows from the fact that it forms two distinct salts with sodium, potassium and ammonium hydroxides. Thus, with caustic soda, the normal sulphate Na_2SO_4, or the bisulphate $NaHSO_4$, may be obtained, according to the relative quantities of acid and alkali brought together. $2NaOH + H_2SO_4 = Na_2SO_4 + 2H_2O$; $NaOH+H_2SO_4= NaHSO_4+H_2O$. Sulphates can also be prepared by the interaction of sulphuric acid with basic oxides, with metals, and with metallic carbonates; insoluble sulphates, e.g. $BaSO_4$ and $PbSO_4$ are best made by precipitation, e.g. $Pb(NO_3)_2+H_2SO_4= PbSO_4+2HNO_3$.

Experiment LXVIII.—*Tests for Sulphates.*

(i) Action of heat. Some sulphates, like barium, lead and calcium sulphates, are unaffected by heating, but most are decomposed at high temperatures, yielding a mixture of sulphur dioxide and sulphur trioxide, water (if originally present as water crystallisation), and an oxide of the metal. (ii) Solutions of sulphates give with barium chloride (or nitrate) solution a white precipitate of barium sulphate, which does not dissolve in hydrochloric acid. The similarly obtained precipitate of barium sulphite dissolves in that acid.

Experiment LXIX. — *Experiments with Sulphates.*

(iii) To prepare the two sulphates of sodium. About 30 c.c. of dilute sulphuric acid are put in a dish, and dilute caustic soda solution is run in from a burette (a graduated tube fitted with a tap which delivers known volumes of liquid) until the solution is neutral, the neutrality being determined by means of litmus or litmus paper. The volume of alkali added is noted. On evaporating off some of the water, fine white crystals of the normal sulphate, $Na_2SO_4 10H_2O$, are obtained. This sulphate is also known as Glauber's salt, and is used as a purgative. The above experiment is repeated, using exactly half the amount of caustic soda and the same volume of acid, thus leaving the liquid acid. The solution is evaporated down to a low bulk, and small, white acid crystals of sodium hydrogen sulphate are deposited on cooling and standing. (iv) A little powdered ferrous sulphate is heated strongly in a hard glass tube: water is evolved, the solid turns white, acid fumes appear, and finally a red residue of ferric oxide is left.

$2FeSO_4=Fe_2O_3 + SO_2+SO_3$. E. H. T.

ELECTRICITY AND MAGNETISM
IX

Local Action.—The simple cell has other defects besides polarisation. The zinc contains impurities, and these react differently with the acid, or do not react with it at all.

One of the conditions under which a current is produced in the simple cell is the presence of two plates which *differ in their chemical action with the acid solution.* In general the greater this difference, the better the cell. Thus a carbon plate is better than one of copper for the positive plate of a cell.

Now the impurities in the zinc plate act as so many dissimilar metals in the cell, hence some of the chemical work is used up in the production of little local currents within the zinc itself. This lessens the current and the defect is known as *Local Action.*

Pure zinc cannot be used, as it has no action on dilute sulphuric acid, and it is obtained with difficulty and expense.

Is there any way of preventing local action ?

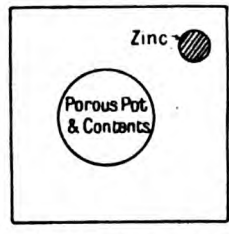


Fig 30.—Leclanché Cell—cross section.

Experiment 29. — *To amalgamate a zinc plate.*

Obtain a very small quantity of mercury from a chemist. Cleanse a piece of zinc by immersing it in the dilute acid solution, pour a few globules of mercury on the zinc, and rub it over the surface by means of a piece of linen. The two metals unite, forming an amalgam. Dip the amalgamated zinc into the acid solution, and note the results (1) when no current is flowing, (2) when the cell is fitted up with a completed circuit.

By providing the plate with a uniform surface, amalgamation has rendered the zinc more lasting, and free from local action.

The student will now have realised that the term electric cell is used to designate an arrangement, consisting of two plates, a positive and a negative, in contact with a solution (or paste) with which they react chemically, one plate doing so more than the other. Zinc is nearly always the material composing the negative plate of any useful cell, and though platinum or copper may be used as a positive plate, carbon is the substance in general use for this purpose.

While studying the structure and mode of working of the chief cells we should bear in mind the conditions that determine the usefulness of any cell :—

(1) The plates employed should react very differently with the solution or paste ; the best conditions being obtained when one plate reacts very energetically with the solution, and the other is not affected at all by it.
(2) There must be good anti-polarisation.
(3) There should be no local action.
(4) The cell must be of convenient size.
(5) The plates should be as near as possible to each other in the solution without touching.

The use of carbon and zinc as the plates satisfies Condition 1. Amalgamation of the zinc satisfies Condition 3.

Conditions 4 and 5 are merely a question of design. The great nuisance to be overcome is the collection of hydrogen on the positive plate, and we have now to see how this is effected in various ways (Condition 2).

The method of anti-polarisation is nearly always chemical in nature, but an apparatus known as Smee's Cell is interesting as illustrating an attempt to get rid of the gaseous bubbles by physical means. The positive plate consisted of platinised-silver, having a large number of minute points off which the hydrogen floated to the surface. But the whole of the gas was not taken away by this means, even if the cell received an occasional shake.

Hydrogen combines with another gas, oxygen, to form water, and in the process the hydrogen is said to be oxidised. Should hydrogen come into contact with a substance rich in oxygen and ready to part with some, water is produced, and the hydrogen removed in this way.

This method of anti-polarisation is used in one or two cells that are much employed at the present time, one of these being the Leclanché Cell.

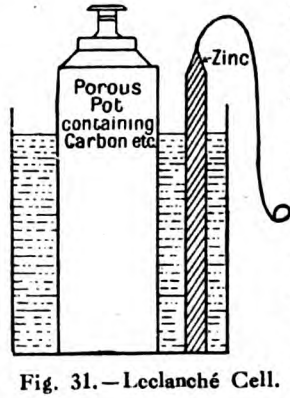


Fig. 31.—Leclanché Cell.

The Leclanché Cell.—A glass jar holds the solution and plates. The negative plate consists of a cylindrical rod of amalgamated zinc, but the positive plate is of a more complex nature (Figs. 30, 31).

A rod of carbon is placed down the central line of a porous earthenware cylindrical pot, the remaining space in the pot being packed with fragments of carbon mixed with a considerable portion of a black powder called manganese dioxide. This substance is rich in oxygen—as the term dioxide implies—and is ready to part with some. The solution contains sal-ammoniac, or, to use its proper chemical name, ammonium chloride. This substance is a white solid that dissolves easily in water, one quarter of a pound of it being sufficient for preparing the solution for one large Leclanché Cell.

The formula for sal-ammoniac is NH_4 CL, and without entering deeply into the chemical working of the cell, we can see where the hydrogen comes from.

When the current flows the zinc combines with a portion of the solution, forming a soluble substance called zinc chloride, and setting free hydrogen. Now this liberated hydrogen causes an interchange of atoms through the solution similar

to that which takes place in a simple cell. Consequently bubbles of the gas come in contact with the earthenware pot, and since this is porous, the gas passes through to meet the manganese dioxide powder ready to yield oxygen. The result is that water is produced slowly, as the cell works. It is a good thing to remove the porous pot and its contents occasionally to allow the water to drain out.

The anti-polarisation is not as complete as it might be, hence a Leclanché Cell is useful for work where a current is not required for more than a few minutes at a time, consequently it is excellent for work in connection with electric bells.

The Dry Cell.—Dry cells work on much the same lines as the Leclanché Cell. Instead of a solution of sal-ammoniac a paste is used, and this reacts chemically with the zinc, which is a hollow cylinder, forming the outer part as well as the negative plate of the cell. The hydrogen is converted into water by oxidation due to its meeting manganese dioxide surrounding the carbon plate.

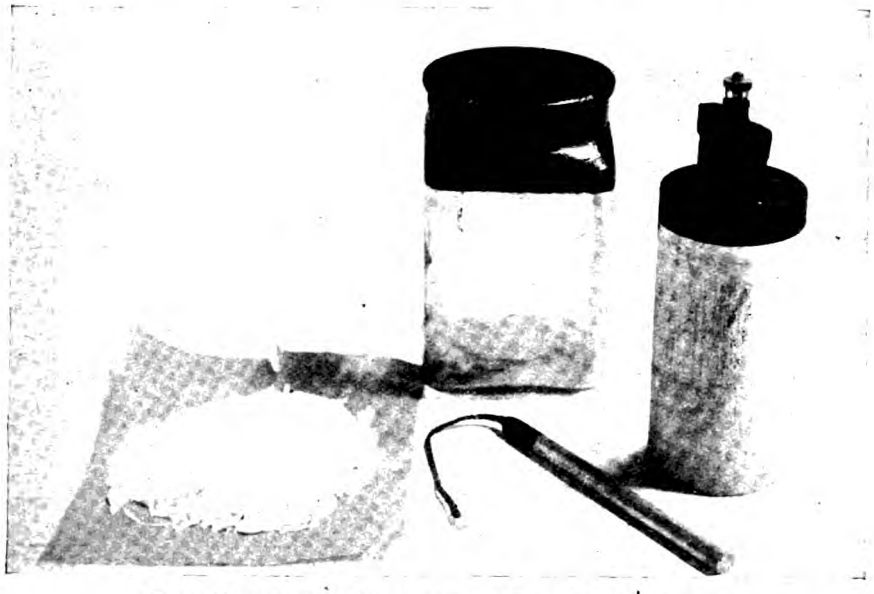
Dry cells vary in price according to size, the smaller ones costing about one shilling. Once the current from a dry cell has been used up, the apparatus is of no further use, but a Leclanché Cell may be charged by making a fresh solution, and by clearing the zinc of white crystals that adhere to it. For bell work, one charge of solution lasts for several months. The sal-ammoniac may be obtained from an oil and colour stores, plumber's, etc., the price being about one shilling per pound.

The Dichromate Cell.—This apparatus that is sometimes termed the bichromate cell, usually consists of a bottle-shaped jar having a movable cap at the top. This cap supports the plates, which are composed of zinc and carbon. There are two pieces of carbon, one on either side of the zinc, but the two are connected by a piece of metal, so that both form the positive plate of the cell.

The use of two pieces of carbon makes both sides of the zinc available for the production of electricity. The effect is the same as that due to a piece of zinc twice the size but facing one carbon plate.

The chemical reactions taking place in the cell are more complicated than those of other cells we have considered. The chief end to be obtained is, of course, the prevention of a gaseous accumulation on the carbon.

As in the Leclanché Cell, this is effected by oxidation due to the use of a substance rich in oxygen, but this time a brownish-yellow substance called potassium dichromate is used, not the black powder, manganese dioxide. The formula for potassium dichromate is $K_2Cr_2O_7$, where K stands for potassium, Cr. for chromium, O for oxygen.



THE COMPONENT PARTS OF A LECLANCHÉ CELL.

Showing the zinc and sal-ammoniac in the foreground, with the glass jar and porous pot behind.

Experiment 30. — *To observe the effect of adding hydrogen to a solution containing potassium dichromate.*

Obtain a small quantity of the dichromate from a chemist, powder it, and put a teaspoonful into a teacupful of water. The solid will dissolve slowly. When sufficient has dissolved to give the solution a brownish-yellow colour, pour it into a glass jar, and add about a tablespoonful of dilute sulphuric acid. Put a small piece of zinc into the mixed solution, and observe that the colour of the solution changes, and that hydrogen gas does not escape as it does when in dilute acid alone. The greenish colour which the solution assumes is due to the formation of new chemical substances owing to the decomposition of the potassium dichromate when it yields oxygen for the oxidation of the hydrogen. The dichromate cell is very useful when a good current is required for a short time, say twenty minutes, but after that the current weakens. Unlike the Leclanché Cell, a new solution must be made frequently for a dichromate cell, especially if it is put to much use (Fig. 32).

Instead of using the dichromate and sulphuric acid, the student can purchase small bottles containing a red substance known as chromic acid. A quantity of this solid equivalent to a teaspoonful will make up one charge of solution for a dichromate cell of one pint capacity.

The Bunsen's Cell.—In each of the cells that we have considered, only one solution is used, except in the dry cell, where no solution is employed. In the Bunsen's Cell two solutions are used, each being kept separate by a porous pot of unglazed earthenware (Figs. 33, 35).

The plates consist of zinc and carbon, the latter in the form of a rod. The zinc is in cylindrical form and fits around the porous pot, but inside the outer containing vessel. A solution of dilute sulphuric acid is put into the partition containing the zinc, but a liquid substance containing much oxygen occupies the porous pot containing the carbon. This liquid is strong nitric acid, a highly dangerous material, which the student should avoid using. Its formula is HNO_3. The formulæ of the various substances used for oxidising the hydrogen are quoted, so that one may get a good idea of their richness in oxygen (O).

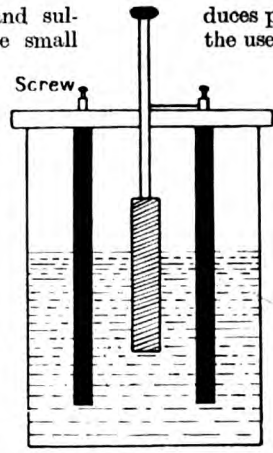


Fig. 32.—Dichromate Cell.

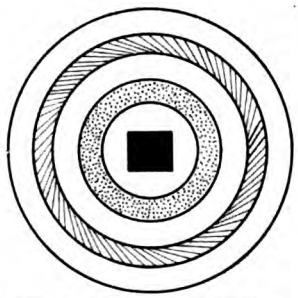


Fig. 33.—Bunsen's Cell—cross section.

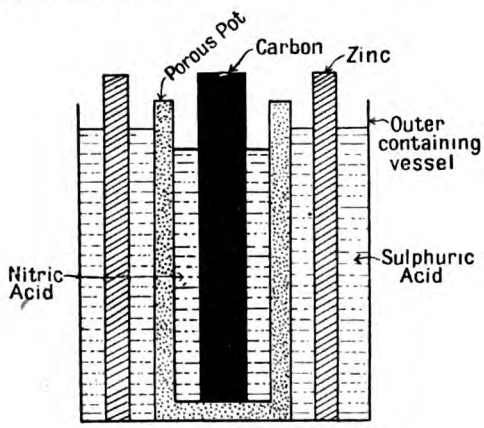


Fig. 35.—Bunsen's Cell.

In the chemical working of Bunsen's Cell the usual atomic interchange of hydrogen takes place, so that this gas appears at the porous cell through which it passes to be oxidised by the strong nitric acid. The decomposition of the nitric acid produces poisonous reddish fumes, which minimise the usefulness of the cell.

Daniell's Cell.—The Daniell's Cell consists of an outer cylindrical copper pot, which serves both as the positive plate of the cell and as the containing vessel. The negative plate is of zinc, which is placed inside a porous pot containing dilute sulphuric acid (Figs. 34, 36).

The space between the porous pot and the copper vessel is occupied by a strong solution of copper sulphate, which is kept up to the required strength by crystals of the copper sulphate being placed on a shelf just below the water line. The hydrogen is converted into sulphuric acid by the action of the copper sulphate solution.

As usual the zinc liberates hydrogen, which passes through the porous pot and meets the copper sulphate in solution. Hydrogen having a more powerful attraction for the SO_4 part of sulphuric acid than copper has, the latter is turned out and hydrogen takes its place. By a process of atomic interchange, as illustrated in the diagram, near the copper vessel free atoms of copper are turned out of the solution and become attached to the copper vessel itself.

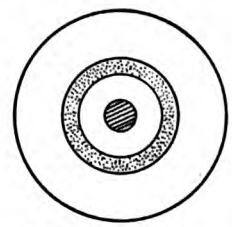


Fig. 34.—Daniell's Cell—cross section.

Another interesting two-fluid cell is Grove's Cell, in which the positive plate consists of thin sheet platinum and the negative plate is of zinc. A porous pot serves to separate the two fluids and to hold the zinc plate, which is immersed in dilute sulphuric acid as usual. The anti-polarising fluid is strong nitric acid, which oxidises the hydrogen as in the Bunsen's Cell.

The whole arrangement is contained in an outer glass vessel.

It should be remarked, however, that the costly nature of platinum and the irritating fumes derived from the nitric acid during the process of anti-polarisation make the Grove's Cell unsuitable for general use.

A very useful apparatus that generates electricity at a constant voltage is the Latimer Clark Cell.

In this particular cell the negative plate is zinc and the positive plate is composed of mercury. The zinc is immersed in a paste consisting of zinc sulphate mixed with sulphate of mercury. This apparatus is not used for giving a continuous current, but is employed as a means of comparison of voltage.

There are two forms of the Clark Cell: the Board of Trade or tubular form, and the H form made by Lord Rayleigh. The E.M.F. of the Clark Cell grows less with rise of temperature.

The strong electric currents required for locomotive and lighting purposes are, of course, generated by means other than by the use of cells—in

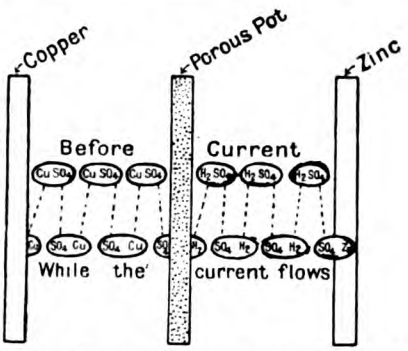


Fig. 36.—Illustrating the process of atomic interchange in a Daniell's Cell.

fact, by machinery driven by steam or water power.

In order to understand the relative practical values of different kinds of apparatus used in the generation of current electricity, we must next consider the important factors known as Electro-Motive Force and Resistance which determine the strength of the currents.

These matters we will deal with next.

L. M. P.

ZOOLOGY.—XVIII

SOME of the wading birds—plovers, snipe, and so forth, have already been dealt with (see page 211). We will now deal with the others.

Wading Birds

The Herons and Storks, though mainly waders, have strong wings enabling them to undertake long migratory journeys. While the Heron may frequently be seen in this country, either in flight or standing in some shallow piece of water fishing, the Stork is very seldom encountered.

The Common Heron is well known in England. When fishing he exhibits great patience, which gives place to almost instantaneous action as his quarry swims past him. Swift and agile in the extreme must be the fish that at such a moment escapes the darting thrust of the Heron's long straight bill. Frogs, mice and water-voles, and even water fowl fall victims to this formidable weapon.

The Egrets are chiefly famous as the unhappy victims whose plumes are in great demand under the title "Ospreys." It is unfortunately true that the terrible persecution to which these birds have been subjected has greatly diminished their numbers.

The White Stork, still common on the Continent, is now seen in Britain only on very rare occasions. The habit of these birds to return to the same nest after the long winter journey to Central Africa or elsewhere has been noted by many writers. It is necessary to point out, however, that experiments with ringed birds have shown that the Stork is, on occasion, just as capable of losing his way as other migrants. Precisely what percentage regain their original nest it is, of course, impossible to say, but we know that some few at least, though they reach the old nesting area, do not arrive within two hundred miles of the point from which they set out. The White Stork feeds principally upon rats, snakes, mice and frogs, though in the East, where dustmen and similar functionaries are unknown, his taste proves rather less delicate.

The Common Bittern

The Adjutant, the largest of his family, sometimes attains a height of five feet. In appearance this ungainly bird is dimly reminiscent of a somewhat elderly man clad in a white vest walking with a stoop, hands clasped beneath the tails of his black morning coat. It is said to have gained its name from its slow and regular walk. The food of the Adjutant has been described in various ways. Practically, however, this bird will eat anything. A puppy, a boiled egg, or offal of repulsive appearance are equally welcomed.

The Common Bittern is found in Europe, Africa, and Asia. As the population increases, however, he is seen in less numbers, since he frequents those marsh lands which man is gradually reclaiming. Its plumage is buff with blue markings, its length about two and a half feet. The Little Bittern is considerably smaller than the Common Bittern, but both species are alike in their highly protective colouring and in their readiness to fight when wounded and unable to escape.

The Sacred Ibis, a native of Africa, was once held sacred in Egypt where its figure carved upon stone is a familiar sight. It is, however, seldom to be seen so far north today, and it is suggested that it was present in other times as a domesticated bird and not in a wild state. The length of this bird runs to nearly three feet, and its beak, whilst long like that of the stork, curves downward towards its point. The Scarlet Ibis, a beautifully coloured bird, is a native of

America, but the Glossy Ibis has on rare occasions been known to visit Britain.

The Spoonbill, so called from the peculiar broadening of the tip of the beak, is occasionally seen on the banks of some British streams, though it is doubtful if it nests here. It is common in many parts of Europe, Africa and Asia.

The Flamingo, an exceedingly beautiful bird of pinkish-white plumage, is a typical "wader" as regards its length of limb, though its webbed feet form a point of difference. The bill again is peculiar, since it retains food whilst it permits water taken with it to strain away. The Flamingo is a native of certain districts in Europe, Africa and Asia.

The Great Bustard, a biggish bird from three and a-half to four feet in height, is common in Asiatic Russia, and may be found in smaller numbers in certain parts of Europe. This bird forms another illustration of the tendency of some birds to rely for safety as much upon their limbs as upon their wings, for the Bustard when chased will, as often as not, take to flight not in the air but upon the ground. Grain, insects and small reptiles form the chief food of the Bustard. The Little Bustard, occasionally to be seen in Britain, is a much smaller bird than his important relative the Great Bustard.

The Cranes, though essentially wading birds, are often to be met with at some distance from water. In appearance they somewhat resemble the Herons, with whom, however, they have little in common. The species are widely distributed over both hemispheres. The Common Crane, a large bird of slate-grey plumage, once migrated to England in large numbers. It is now, however, very rarely seen, a fact with which the gradual reclamation of our swamp lands may have had something to do. The Demoiselle Crane, of various regions in Africa, Southern Europe, and Asia, is a much smaller bird of handsome appearance.

The Common Water-Rail is to be found about the marshes, rivers and streams of Europe. Less than a foot in length and with a body well adapted to making a way through the reeds which constitute its favourite environment, the Rail is by no means easily secured. It is a clever swimmer and upon occasion can remain under water for an appreciable time.

The Land-Rail, while necessarily mentioned with his kind, may generally be found over long grass and cultivated land. He is a frequent summer visitor to these islands, though his timid disposition tends to keep him from observation.

The Coot, a somewhat squat bird of subdued plumage, is a resident in Britain. Upon his forehead he carries the white patch which is said to have originated the phrase, "As bald as a Coot." He takes naturally to the water, and in many respects resembles the better-known Moorhen. The Moorhen may be found upon most British pools fringed by reeds or long grass in which it can hide. It is about twelve inches in length, of brown-and-white plumage.

Photo: Martin Duncan.

SPOONBILL,

so called from the peculiar broadening of the tip of the beak, is sometimes seen on the banks of British streams.

The Duck tribe, including the Swans and Geese, have large egg-shaped bodies, legs that are placed far back upon the body, and webbed feet. Their bills carry upon the upper mandible a series of upright plates which retain food whilst allowing water to run freely away.

The Grey Lag Goose, a migrating bird that is found throughout Europe and Central Asia, is the progenitor of our domestic Goose. When flying in large flocks these birds assume a **V**-shaped formation, the leader of the flock occupying the point of juncture between the two lines. The Grey Lag Goose is a large bird about three feet in length. The Bean Goose, a darker and much smaller bird than the goose just mentioned, the Brent Goose, which breeds in northern regions, the Pink-footed, the Bernicle and the White-fronted Goose are all among the periodical visitors to these islands. The Snow Goose is a North American bird.

The Swans, without question the most

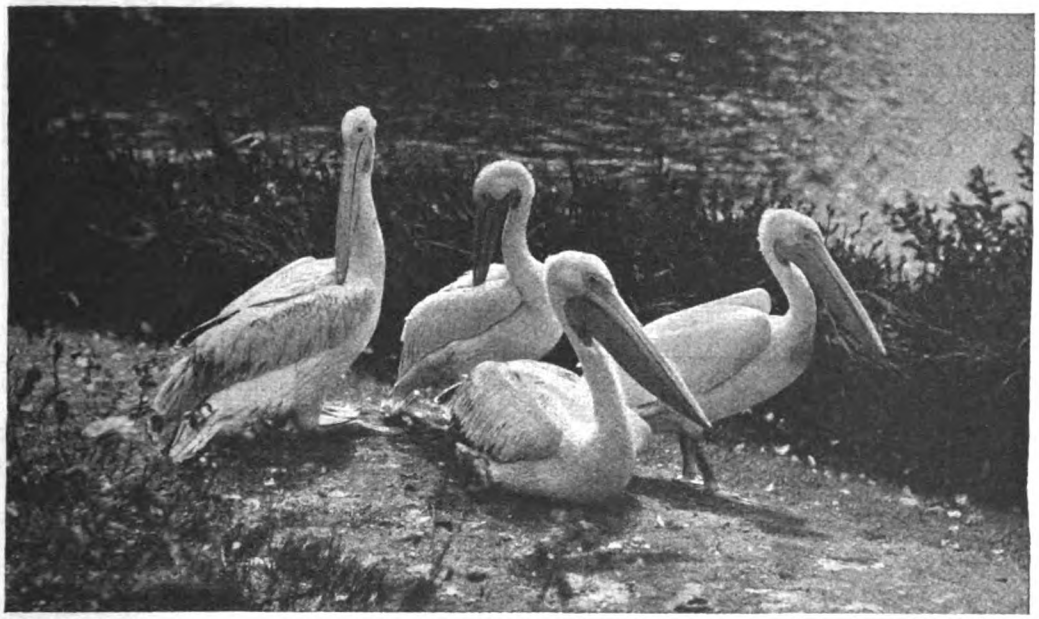


Photo: Charles Reid, Wishaw.

PELICANS

present a remarkable appearance owing to their squat figures and very long bills. From the lower mandible hangs a pouch with which the bird scoops in his catch when fishing.

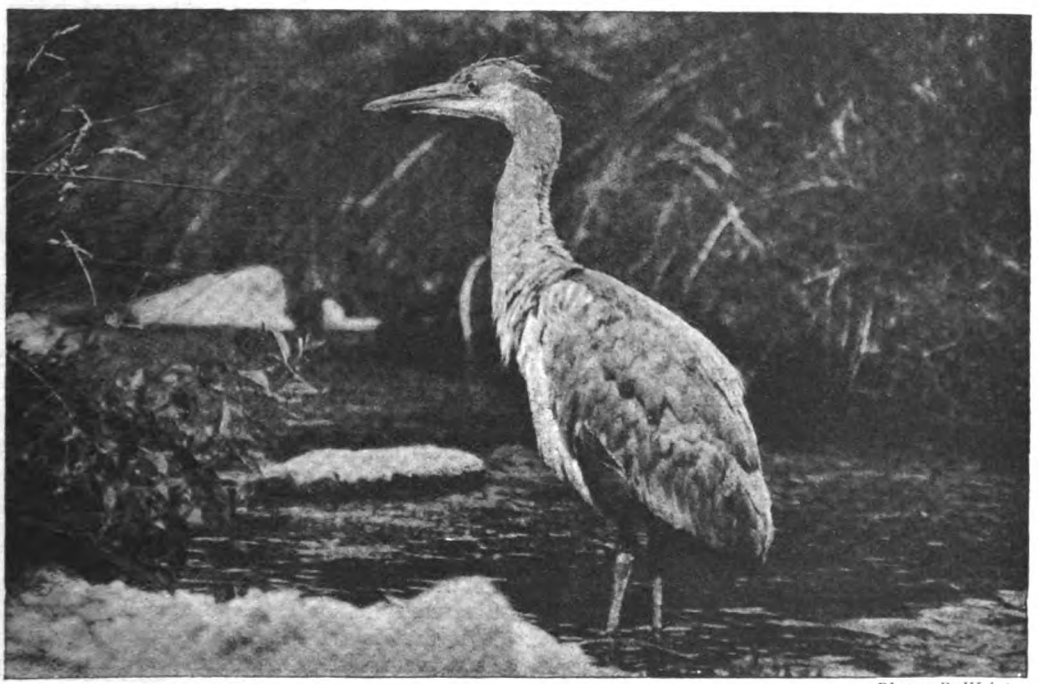


Photo: P. Webster.

HERON

when fishing exhibits great patience, which gives place to almost instantaneous action as the quarry swims past. The bird may be seen in most parts of Britain.

handsome birds of this family, include a number of species of which the best known in Britain is called the Mute Swan. It is this bird which frequents the Thames, where it is fortunately protected, and numerous inland waters. The Wild Mute Swan, as distinct from the semi-domesticated British bird, is extensively found in Europe and in parts of Central Asia. It is a migrating bird, but does not reach these shores except upon the rare occasions upon which an individual bird is blown from its course.

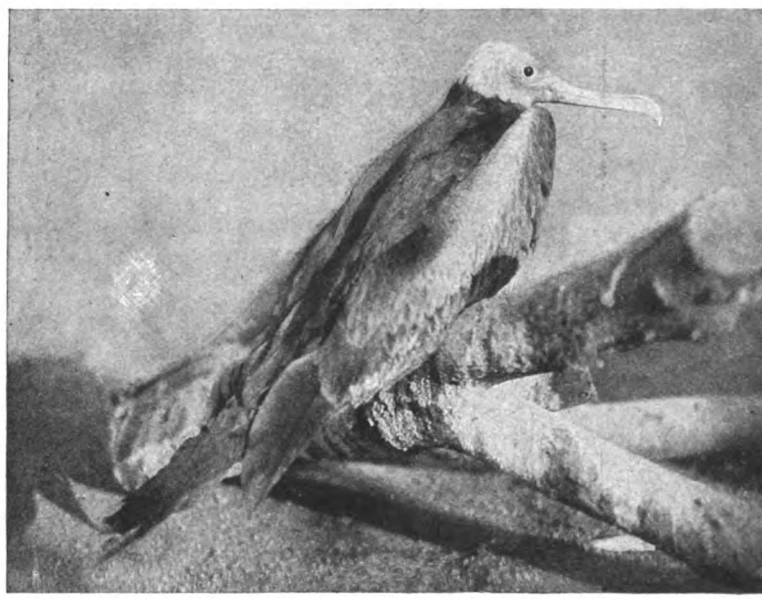


Photo: W. S. Berridge.

FRIGATE BIRD.

A denizen of tropical regions. Noted for his extraordinary powers of flight.

The Whooper favours the colder regions of northern latitudes, but may be seen in Scotland during the winter. The same remark holds true of Bewick's Swan. The Black Swan, frequently to be seen upon ornamental lakes in Britain, is an Australian bird.

The Mallard, or Wild Duck, is a regular winter visitor to Britain, though he rarely nests in these islands. It is from this bird that our domestic breeds, which greatly exceed it in size, are descended. The Wild Duck feeds principally upon water insects and frogs. The Sheldrake, a larger bird, is found off our eastern coasts. The Shoveller, who gains his name from the shape of his bill, still breeds in England, as do also the Pin-tail, the Teal and the Widgeon.

The Eider Duck breeds along our northern coasts and in the Shetland and Orkney Islands and in the Hebrides; for the most part, however, the birds seen in Great Britain are migrants. When nesting the female bird is strangely tame, and will allow itself to be stroked without attempting to leave its eggs. The nest is lined with down taken from the bird's own body. This down is, of course, well known as a favourite form of bed cover. The Goosander, another migrant to be seen on our northern coasts, is a great fish eater. Other Ducks which annually visit us are too numerous to be mentioned in detail. Amongst them is the Scoter.

The Cormorants, Gannets, Darters, Frigate Birds, Tropic Birds and Pelicans form an order termed *Steganopodes*, the members of which are distinguished by the web which joins the four toes.

Gannets

The Common Cormorant is to be found in most parts of the world, but not in Australasia. The fully-grown bird is about three feet in length. The usual nesting-place of the Cormorant is some rocky part of the coast. Here it raises its young amid a scene of wretched disorder. Decomposed fish, dead and crushed fledglings, streams of guano are everywhere to be seen. Such is the horrible uncleanliness of the Cormorants' breeding-ground that for years neither moss nor lichen will grow upon the site. In certain parts of the world the Cormorant, despite its webbed feet, may be seen perched upon the branch of a tree. As a fisher the bird is exceedingly successful, his diving abilities permitting him to hunt his quarry beneath the surface of the water. This fact is still turned to account in the East, where the Cormorant, so ringed as to prevent it from swallowing, retrieves fish for its owner.

The Gannet or Solan Goose is a fish-eating bird about equal in length to the Cormorant. Its bill, which is of a fair length, tapers to a long point, and its plumage is mostly white. The bird is very plentiful on some parts of the

coast. On Bass Rock and at St. Kilda especially it nests in amazing numbers, which yield the most remarkable spectacle when the birds are induced by some fright simultaneously to take to the air.

The Darters, native to South America, Australia, Africa and India, are excellent swimmers and fishers who have earned their name by the suddenness with which they hurl themselves upon their prey from the overhanging branch of a tree.

Pelicans

The Frigate Bird is found in tropical and semi-tropical regions, and is noted for his powers of flight, in which respect he is sometimes held to excel all other birds. The Tropic Bird, another powerful flier, feeds largely upon flying fish.

The Pelican, an inhabitant of tropical and temperate regions, presents an extraordinary appearance by reason of its somewhat squat figure and the inordinate length of its bill. From the lower mandible there hangs a large pouch with which the bird when fishing scoops in his catch. The old wives' story that the Pelican feeds its offspring with its own blood is, of course, entirely devoid of truth, though it is a fact that the fledgling for a time feeds upon the food carried by the parent bird in his pouch.

The Common Gull

The Gulls and Terns, of the family *Laridae*, possess three webbed toes, the fourth toe being small and free. The Gulls are a most numerous tribe, the species of which are scattered throughout the world. Several species may be seen in British waters.

The Common Gull, which is largely a study in white and grey, is about a foot and a half in length. As a scavenger he is indefatigable, for there is very little in the way of offal that he will decline. His nest may usually be found on the shores of some bay or other piece of water in close proximity to the sea. The Herring Gull, a slightly larger bird than the Common Gull, has a very extensive range and is largely a fish eater, though he often searches the fields for worms and insects.

The Great Black-backed Gull, the largest of the British species, occasionally attains a

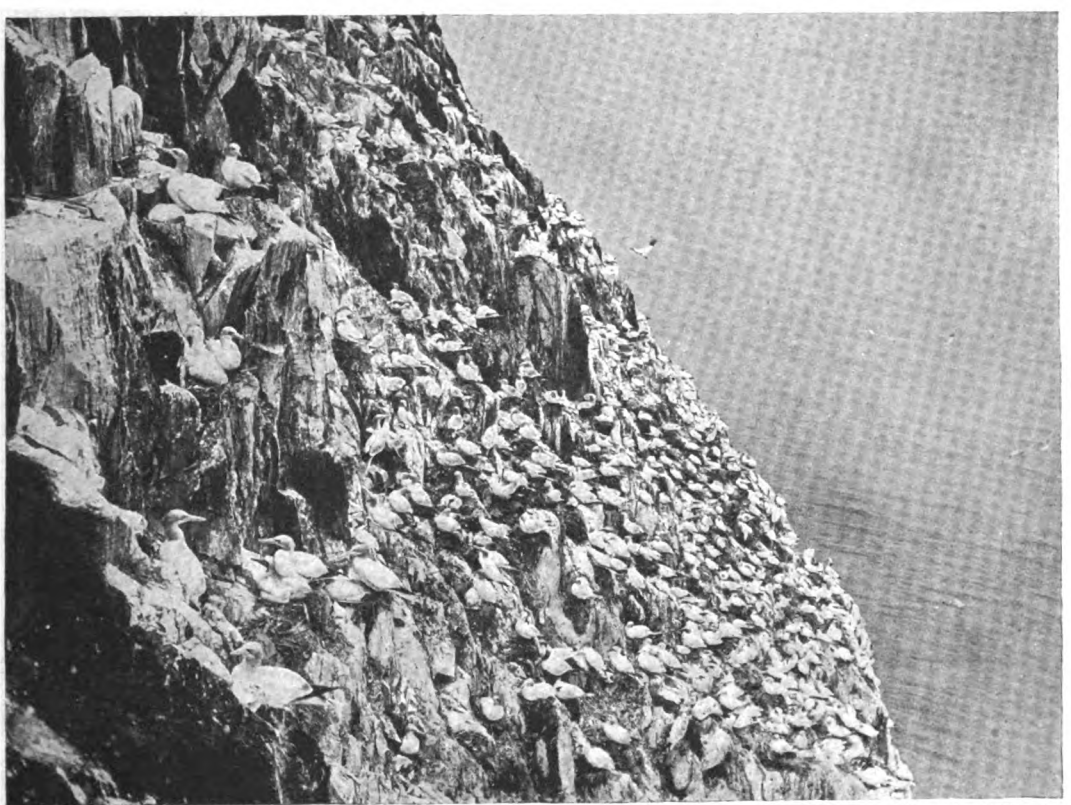


Photo: J. Williamson.

GANNETS ON THE BASS ROCK

where, as at St. Kilda, amazing numbers of these birds nest.

length of two and a half feet. Though his breeding grounds are on the northern shores of these islands, he is quite common on all our coasts. He shows, when feeding, sympathies of the widest kind, and will devour a snail or a mouse as readily as a fish or some other bird. Mr. Kearton, in his interesting description of bird life at St. Kilda, describes one of these birds trying to secure a sick or injured Puffin for his dinner. His intended victim, however, apparently understood his tactics only too well, and by constantly diving wearied out the patience of his scoundrelly assailant.

The Skua, or Robber Gull, a large brown-coloured bird, devours smaller birds, eggs, fish and carrion of different sorts. When possible, the Robber Gull profits by the industry of smaller Gulls by eating their catch after they have been to the trouble to secure it. Owing to his size the smaller Gulls are seldom inclined to make the robbery a *casus belli*.

The Arctic Tern is common in the Orkneys and Hebrides, and even breeds on the Scottish coasts. The Skimmers are interesting members of the Tern tribe in whom the lower mandible, which is very thin, is longer than the upper.

Types of Petrels

The Albatrosses and the Petrels, of the order *Tubinares*, are distinguished from other marine birds by their tubular nostrils, the tube running for a short distance parallel with the top mandible.

The Wandering Albatross is easily the greatest of all living birds, its wing-spread from tip to tip being as much as twelve feet. Its range is limited to the southern oceans, but it is infrequently seen. Only at the breeding season does this magnificent bird seek the land, and then only the most remote shores are chosen.

The Storm Petrel is probably the best known of the British Petrels. This bird, sometimes called the "Mother Carey's Chicken," is about six inches in length and has dark plumage.

Another type, the Fulmar Petrel, a considerably larger bird than the Storm Petrel, breeds in the extreme north of the British Isles, being especially numerous in the islands of St. Kilda. Like the Storm Petrel the Fulmar when molested ejects oil from its mouth in the direction of the aggressor. The Giant Petrel, with a wing-spread of about five feet, ranges in southern latitudes and is known to spend a great part of its time on the wing.

A. B.

BOTANY.—III

6. Food-Stores in Seeds.—It will have been noticed in every case of growing seeds that the solid substance of the seed gradually disappears as the young plant grows. In the seeds called epigeal, indeed, the food-store is very early used up; in hypogeal seeds very little of it remains when the true leaves have begun to appear. We have now to inquire into the nature of this food-matter which enables the young plant to grow.

Demonstration VIII

Obtain a little tincture of iodine from the chemist, and dilute it with water until it is of a deep straw colour. Into a little of this solution dip a grain of maize which has been cut across. It will be observed that the endosperm is stained blue, and is sharply marked off from the embryo, which is stained yellow. The blue colour produced by iodine indicates the presence of *starch*. Try this experiment with other seeds, and it will be found that starch is at all events a very frequent, if not universal, constituent of the food-store of seeds.

Pure starch is a white amorphous powder which does not dissolve in cold water; hence starch, of itself, cannot be available as food for the young plant, unless, by some change in it, it can be made soluble and thus be transmitted in liquid form to the growing parts of the plant. A change has to take place in the starch of the seed, similar to that which takes place in the starch of our own food during digestion, and for the same reason; the insoluble starch cannot be absorbed into the blood and carried about the body.

Demonstration IX

In order to examine this change we need a special chemical reagent called Fehling's solution.* This is a deep blue liquid, and when it is boiled with grape-sugar (or glucose) a brownish-yellow deposit is produced.

Grow some grains of wheat half covered with water for a few days; test the water with Fehling's solution, and the presence of grape-sugar will be indicated. A few drops of the water, put with a drop of iodine, will show that no starch is present. Further, if grains of wheat are boiled with water before germination, no grape-sugar is obtained in the solution. Hence grape-sugar is produced in the seed during germination.

That the grape-sugar is produced from the starch is suggested by the following analogous experiment.

Demonstration X

Take a little starch—the juice squeezed out of a raw potato will do very well—and dissolve it in boiling water in a test-tube; then add a little saliva

*This is made by dissolving the copper hydroxide produced by adding sodium hydroxide to copper sulphate solution in excess of Rochelle salt solution.

from the mouth, and keep the mixture just below the boiling-point for about 10 or 15 minutes. Test the resulting liquid with Fehling's solution and grape-sugar will be shown to be present. The same change could have been produced by boiling the starch solution with a drop or two of hydrochloric acid.

These experiments justify the suggestion that grape-sugar is produced during germination from the starch stored up in the seed; and as grape-sugar is readily soluble, it is easy to understand how it becomes available for the plant. During germination there develops in the seed a substance called *diastase*; and this is the active agent in the conversion of starch into grape-sugar. It is similar in behaviour to the active principle in saliva; a very small quantity of it is able to produce a great amount of transformation, and without it the change cannot even be started. A large class of substances similar to diastase is known in physiology; they are spoken of as *enzymes*, and they carry forward those chemical changes upon which the nutrition of the plant or animal depends.

Grape-sugar differs from ordinary cane-sugar in its appearance and its slight sweetness, as well as in its action towards Fehling's solution, which is not affected by cane-sugar. Nevertheless, both these sugars and starch are very closely related to one another. They all consist of carbon, hydrogen and oxygen, with the two latter elements in the water-ratio; hence they are spoken of as *carbohydrates*—a group of compounds of great importance in the science of life. In chemical symbols they are represented by the formulæ $C_6H_{12}O_6$ (grape-sugar), $C_{12}H_{22}O_{11}$ (cane-sugar) and $C_6H_{10}O_5$ (starch).

Photo: L. Bastin.

Seeds will germinate in a stoppered bottle only if there is sufficient oxygen. One pea placed in a little water will grow into a plant, but—

Important as they are, however, the carbohydrates cannot by themselves sustain life. The material basis of life is a substance called *protoplasm*, and without this there can be no life. Now, protoplasm contains nitrogen, as well as carbon, hydrogen and oxygen; consequently some foodstuff containing nitrogen must be supplied, if protoplasm is to be formed. The necessary material is found in a class of substances called *proteins*.

Photo: L. Bastin.

—a number of germinating seed will exhaust the oxygen. This may be proved by thrusting a lighted match into the bottle; the match will go out.

All seeds contain some kind of protein; but the proteins are very complex substances and difficult to examine by simple tests. They are not always easy to identify; and though they turn yellow with iodine, this colour is masked by the blue starch-reaction, and requires the microscope to reveal it. Nothing is known, either, of the enzyme which makes the store of protein available for the growing embryo. Though proteins will be universally present, therefore, in seeds, it will not always be so easy to demonstrate the fact as it is in the grain of wheat.

DEMONSTRATION XI

Place some ordinary wheat flour on a piece of muslin, and tie the muslin on to the water-tap. Let the water run slowly through the flour for some minutes. The starch will slowly dissolve, and on the muslin a sticky substance will remain. This is gluten, the protein in wheat.

Heat a little of the gluten in a dry test tube, and notice the peculiar odour of burnt feathers, which is characteristic of a protein. Heat a little starch in the same way, and notice the odour also. In

both cases, there will be nothing left at the finish but a little charcoal.

Careful analysis of proteins shows that they contain all the elements essential to the formation of protoplasm, viz. carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus. But the fact that carbohydrates are also of vital importance leads us to suppose that protoplasm may be richer in carbon, hydrogen and oxygen than proteins are. We shall not be able to settle this point definitely, because, as soon as we begin to analyse living protoplasm, we kill it, and it is no longer protoplasm.

No substance can replace a protein in the seed; but starch may be replaced by other carbohydrates, such as the sugars, etc., and in a few cases by oils or fats, which are also compounds of carbon, hydrogen and oxygen. The oil acts like the carbohydrate, though we do not know how it is changed, in germination. Well-known examples of seeds containing oil are the castor-oil bean, linseed (flax), coco-nut, and others. In the coco-nut, the endosperm is partly liquid and partly solid.

Unique is the endosperm of the date, which consists throughout of hard *cellulose*, a complex carbohydrate, usually very difficult to alter into other forms. The other materials met with in seeds, such as the fragrant essences in some spices, are not as a rule of value as food-stores, and only occur incidentally and in small quantities.

7. Metabolism.—One of the most peculiar properties of protoplasm is its power of making more protoplasm when it is supplied with the proper materials, *i.e.* proteins and carbohydrates. The embryo plant, containing a certain amount of protoplasm, can use the foodstuffs supplied to it and assimilate them to itself, make more protoplasm and thus grow. But living protoplasm does not thus go on indefinitely increasing itself; an opposing process is at work, which tends continually to destroy it.

Hence it is clear that protoplasm is in a continual state of flux or change, of being made and destroyed; which process, known as *metabolism*, is peculiar to protoplasm and is the mainspring of all vital activity. All those activities, which especially characterise life in any form, are accompanied by, it is probably fair to say are caused by, the metabolism of the protoplasm.

A living plant is quite like a complex engine in this respect: it does work by means of the energy liberated through the transformation of matter. Just as the burning of coal accounts for the motion of a locomotive, so the destruction of its protoplasm accounts for the growth of a plant. And the destruction is essentially a process of burning in the plant's case also. For the oxygen, without which, as we saw in Lesson II, a growing embryo does not thrive, really burns the protoplasm and causes its disintegration, producing carbonic acid gas and other products which it is needless to discuss here. We merely wish to emphasise the need of oxygen to the plant. It is as necessary as it is in a coal fire, because combustion cannot take place without it.

The outward sign that this process goes on in the plant is found in its effect on the air. Close some growing seedlings in a bottle; the air gradually loses its oxygen, and carbonic acid gas takes its place. The latter gas, as its name implies, contains carbon as well as oxygen (CO_2). This carbon is taken from the carbon of the protoplasm; the carbonic acid is the product of the destructive side of the metabolism of the living substance. The process by which the oxygen of the air is taken in to the plant and carbonic acid gas given out is generally spoken of as *Respiration*, because of its resemblance to the process of breathing in animals.

The essential nature of the process is the same in each case; the animal has special organs of respiration, which the plant has not; and the animal breathes far more oxygen than the plant, because it does infinitely more work. These, however, are matters of detail and of degree.

The important thing that should be noted is that protoplasm needs foodstuffs to make it and oxygen to unmake it, and that this double process, or metabolism, is the unique property of protoplasm. Without protoplasm new protoplasm cannot be made; *omne vivum ex vivo*.

During the process of metabolism the plant, like the animal, produces a number of waste products which it has to dispose of in one way or another.

Carbon dioxide (CO_2) is one of these, and, being a gas, is easy to get rid of by diffusion with the entering air.

There are others, however; and, as plants have no special organs for excretion, these accumulate within the plant, and are generally made to serve some useful purpose, though this is not always evident. Such substances are the resins and vegetable gums; the vegetable alkaloids such as strychnine—some of which occur in seeds; tannin which occurs in bark and other plant-coverings; and many others. E. W. E.

Continued from page 225.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A.[Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—XXI

THIRD DECLENSION

THE Greek nouns that belong to the third declension are very numerous, but they retain only a few of their Greek forms.

Greek Derivatives

Greek nouns in **-ōs, -ō, -ēus**, and **-ў̆s**, are declined as follows :—

hērōs, *hero* ; **Atreūs**, *Atreus*.

	Sing.	*Plur.*	
Nom.	hērōs	hērōĕs	Atreūs.
Voc.	hērōs	hērōĕs	Atreū.
Acc.	hērōă	hērōăs	Atrĕum *or* Atrĕă.
Gen.	hērōĭs	hērōum	Atrĕī *or* Atrĕōs.
Dat.	hērōī	hērōĭbŭs.	Atrĕō *or* Atrēi.
Abl.	hērōĕ	hērōĭbŭs.	Atrĕō.

Dīdō, *Dido*; **ēchō**, *echo*; **Tēthў̆s**, *Tethys*.

Nom.	Dīdō	ēchō	Tēthў̆s.
Voc.	Dīdō	ēchō	Tēthў̆.
Acc.	Dīdō *or* Dīdōnem	ēchō	Tēthў̆n.
Gen.	Dīdūs *or* Dīdōnĭs	ēchūs	Tēthў̆ŏs.
Dat.	Dīdō *or* Dīdōnī	ēchō	Tēthў̆ī.
Abl.	Dīdō *or* Dīdōnĕ	ēchō	Tēthў̆ĕ.

The accusative singular in **-ŏă** and the accusative plural in **-ās** are common features of Greek nouns in Latin, and the genitive in **-os** is a frequent alternative with that in **-ĭs**.

Nouns in **-ăs** and **-ĭs** are usually imparisyllabic, as :—

Pallas, *Pallas* (Minerva); **lampas**, *torch*.

	Sing.		*Plur.*
Nom.	Pallăs	lampăs	lampădēs.
Voc.	Pallăs	lampăs	lampădēs.
Acc.	Pallădem *or* Pallădă	lampădă	lampădās.
Gen.	Pallădĭs *or* Pallădŏs	lampădŏs	lampădum.
Dat.	Pallădī	lampădī	lampădĭbŭs.
Abl.	Pallădĕ	lampădĕ	lampădĭbŭs.

Paris, *Paris* (son of Priam); **tigrĭs**, *tiger*.

Nom.	Părĭs	tigrĭs	tigrēs.
Voc.	Părĭ	tigrĭs	tigrēs.
Acc.	Paridem, Părĭdă, *or* Părĭn	tigrim	tigrēs *or* tigrĭdās.
Gen.	Părĭdĭs, Parĭdŏs	tigrĭs *or* tigrĭdĭs	tigrĭum.
Dat.	Părĭdī	tigrī *or* tigrĭdī	tigrĭbŭs.
Abl.	Părĭdĕ	tigrĕ *or* tigrĭdĕ	tigrĭbŭs.

Greek nouns in **-ēs** and **-is** (also **-ў̆s**) take **-ēn** and **-in** (also **-ў̆n**), as well as **-em** and **-im** (also **-ym**), in the accusative singular, and **-ī** as well as **-ĭs** in the genitive singular. **Sōcrătēs** and **Pĕrĭclēs** are declined as follows :—

Nom.	Sōcrătēs	Pĕrĭclēs.
Voc.	Sōcrătē	Pĕrĭclēs, Pĕrĭclĕs, *or* Pĕrĭclē.
Acc.	Sōcrătēn	Pĕrĭclem *or* Pĕrĭclĕă.
Gen.	Sōcrătī *or* Sōcrătĭs	Pĕrĭclī *or* Pĕrĭclĭs.
Dat.	Sōcrătī	Pĕrĭclī.
Abl.	Sōcrătĕ	Pĕrĭclē.

Greek neuters ending in **-mă** have the genitive singular in **-mătĭs** and their dative and ablative plural in **-mătīs** instead of **-mătĭbŭs**, as **pōēmă**, *poem*, gen. sing. **pōēmătĭs**, dat. and abl. plur. **pōēmătīs**.

Irregular Nouns

There remain several other important classes of anomalous nouns, comprising heterogeneous and heteroclite nouns, nouns used only in the plural or which vary their meaning in the plural, etc.

(1) Heterogeneous nouns are those having a different gender in the plural. The following are some of the most important :—

Sing.	*Plur.*
carbăsŭs (f.), *canvas.*	carbăsă (n.), *sails.*
frēnum (n.), *bit.*	frēnī (m.), *or* frēnă (n.).
iŏcŭs (m.), *jest.*	iŏcī (m.), *or* iŏcă (n.).
lŏcŭs (m.), *place.*	lŏcă (n.) (lŏcī is used in the sense of *places in a book* or *topics*).

(2) Heteroclite nouns are those declining the plural or other forms according to a different declension from that of the nominative singular. The following are the chief :—

Sing.	*Plur.*
balnĕum (n.), *bath.*	balnĕă (n.), *baths.* balnĕae (f.), *bathing-house* or *public baths.*
dēlīcĭum (n.), *delight.*	deliciae (f.), *delights, darling.*
vās (n.), *vessel.*	vāsă, vāsōrum, vāsīs (n.), *vessels, plate, baggage.*

Like **Dŏmŭs**, *house*, already referred to (Vol. I., p. 225), some nouns (especially names of trees) are declined according to both the second and fourth declensions ; example, **pīnŭs**, *pine-tree.*

(3) The following nouns have one meaning in the singular and another in the plural :—

Sing.	*Plur.*
aedēs (f.), *temple.*	aedēs, *house.*
ăquă (f.), *water.*	ăquae, *medicinal springs.*
auxĭlĭum (n.), *help.*	auxĭlĭă, *auxiliary forces.*
balnĕum (n.) *bath.*	(*See* heteroclite nouns above.)
carcer (m.), *prison.*	carcērēs, *starting-place* (in a race).
castrum (n.), *fort.*	castră, *camp.*

(4) The following are used in the plural only :—

armă, *arms.*	lībĕrī, *children.*
cūnae, *cradle.*	mānēs, *spirits of the departed.*
dīvĭtĭae, *riches.*	moenĭă, *town walls.*
fasti, *annals.*	nūgae, *trifles.*
fēriae, *holidays.*	nuptĭae, *marriage.*
indūtĭae, *truce.*	praecordĭă, *heart.*
insīdĭae, *ambush.*	tĕnēbrae, *darkness.*

So also the names of some towns, as **Athēnae**, *Athens*, **Faesŭlae**, *Fiesole*, **Fălērĭī** *Falerii*, and **Syrācūsae**, *Syracuse*, and names of days, festivals, etc., as **Bacchānālĭă**, *feast of Bacchus*, **Kălendae**, *Calends.*

(5) Some nouns have no plural owing to their meaning, as proper, abstract, collective, or material substantives, as **ignōrantĭă**, *ignorance*, **justĭtĭă**, *justice*, **plebs**, *the people*, **argentum**, *silver*, etc.

(6) Some nouns are defective or lacking in certain cases. We have already met with a few of these. Among the most important are **dăpes** (plur.), *feast*, **frūgem** (acc.), *crop*, **ŏpem** (acc.), *help*, **prĕcem** (acc.), *prayer*, **vĭcem** (acc.), *change*, and **vīs**, *strength*, declined as follows :—

			Sing.			
Nom.						**vīs.**
Acc.	dăpem	frūgem	ŏpem	**prĕcem**	**vĭcem**	**vim.**
Gen.	dăpĭs	frūgĭs	ŏpĭs		**vĭcĭs (rare)**	
Dat.		frūgī (usually an adjective)		**prĕcī**		
Abl.	dăpĕ	frūgĕ	ŏpĕ	**prĕcĕ**	**vĭcĕ**	**vī.**
			Plur.			
Nom.	**dăpēs**	frūgēs	ŏpēs	prĕcēs	vĭcēs	vīrēs.
Acc.	dăpēs	frūgēs	ŏpēs	prĕcēs	vĭcēs *or* vĭcīs	vīrēs *or* vīrīs.
Gen.		frūgum	ŏpum	prĕcum	vĭcĭŭm	vīrĭŭm.
Dat.	dăpĭbŭs	frūgĭbŭs	ŏpĭbŭs	prĕcĭbŭs	vĭcĭbŭs	vīrĭbŭs.
Abl.	dăpĭbŭs	frūgĭbŭs	ŏpĭbŭs	prĕcĭbŭs	vĭcĭbŭs	vīrĭbŭs.

cŏmĭtĭum (n.), *place of assembly.*	cŏmĭtĭă, *assembly, election.*
cōpĭă (f.), *plenty.*	cōpĭae, *troops.*
fascīs (m.), *bundle, faggot.*	fascēs, *lictor's fasces.*
fīnīs (m.), *end, boundary.*	fīnēs, *territory.*
grātĭă (f.), *favour.*	grātĭae, *thanks.*
hortŭs (m.), *garden.*	hortī, *pleasure-grounds.*
impĕdīmentum, *hindrance.*	impĕdīmentă, *baggage.*
lĭtĕră (f.), *letter* (of the alphabet).	lĭtĕrae, *epistle, literature.*
lūdŭs (m.), *game, pastime.*	lūdī, *public games.*
ŏpem (acc.) (f.), *help* (see defective nouns above).	ŏpēs, *resources.*
ŏpĕră (f.), *work.*	ŏpĕrae, *gang of workmen.*
pars (f.), *part.*	partēs, *party, part* (in a play).
rostrum (n.), *beak* (of a bird or ship).	rostră, *the Rostra* (in the Forum).
săl (m. or n.), *salt, wit.*	sălēs (m.), *witticisms.*
tăbŭlă (f.), *board, picture.*	tăbŭlae, *writing-table.*

Sordēs (plur.), *squalor*, has the acc. sing. **sordem**, and rarely the abl. **sordĕ** ; **dītĭōnem**, *dominion*, has no nominative in sing. or plur. ; **fors**, *chance*, has only the abl. sing. **fortĕ** ; **nēmō**, *no one*, has only the acc. sing. **nēmĭnem** and dat. **nēmĭnī**, the other cases being supplied by **nullĭŭs**, gen., and **nullō** or **nullā**, gen. and abl. of **nullŭs** ; **spontĕ**, abl., and **spontĭs**, gen., are the only cases of a missing noun, **spons**, *one's own accord.*

(7) The following nouns of the neuter gender are indeclinable, being used only in the nominative and accusative singular :—

fas, *that which is lawful or right.*	nīhĭl or nīl, *nothing.*
instăr, *resemblance.*	părum, *too little.*
nĕfās, *that which is unlawful, sin.*	sătĭs, *enough.*

Nĭhĭlum (nīlum), *nothing*, is regularly declined in the singular. **Mānĕ** (old locative **mānī**), *in the morning*, occurs only in the ablative. Similar are **iūssū**, *by command*, **iniussū**, *without command*, and **pondō**, *by weight*.

This brings our study of Latin Accidence, or the form of words, to an end.

With the lessons that follow, we shall proceed to the other main division of Latin Grammar, namely, Syntax, or the rules governing the combination of words in a sentence.

VOCABULARY

ignavia, -ae, (f.), *idleness, sloth, cowardice.*
ilex, -icis (f.), *the holm-oak.*
improbe (adv.), *wrongly, dishonesty.*
linum, -i (n.), *linen.*
lino, -ĕre, livi *and* lĕvi, litum, *to smear upon.*
loquor, -i, locutus sum, *to speak.*
lux, lucis (f.), *light.*
lyra, -ae (f.), *lyre.*
lupus, -i (m.), *wolf.*
munditia, -ae (f.), *cleanness, elegance.*
murex, -icis (m.), *the purple-fish.*
mus, muris (c.), *a mouse.*
Musa, -ae (f.), *a muse, goddess of poetry, music.*
mutus, -a, -um, *dumb.*
navis, -is (f.), *ship, vessel.*
nidus, -i (m.), *nest.*
opto, -are, -avi, -atum, *choose, select.*
persuādĕo, -ēre, persuasi, persuasum, *to convince.*
semita, -ae (f.), *a foot-path.*
senex, senis (m.), *an old man.*
sera, serae (f.), *a bar or movable bolt.*
tĭmĕo, -ŭi, 2, *to be afraid, fear, apprehend.*
tĭmĭdas, -atis (f.), *fearfulness, timidity.*
tingo (tinguo), tinxi, tinctum, 3, *to wet, moisten.*
tŏga, -ae (f.), *a covering, white garment worn by Roman citizen.*
tondĕo, tŏtondi, tonsum, 2, *to shave, clip, shear.*
tŏno, -ŭi, 1, *to sound, resound.*

Exercise 20

Translate into English:—

1. Credibile non est, quantum scribam die, quin etiam noctibus. 2. Hic dies et Romanis refecit animos et Persia perculit. 3. Non tamen Aenean, quemvis male cogitat, odi. 4. Patriae quis exul se quoque fugit? 5. Grates persolvere dignas non opis est nostrae. 6. Eius nulla culpa est cui parere necesse sit.

Translate into Latin:—

1. I will strive with all my strength and effort. 2. The god will grant an end to these also. 3. My blood and strength are already failing me. 4. Whatever is not permitted, we must consider a sin. 5. There is a great multitude of robbers in this region. 6. Abundance of things produces abundance of words.

Key to Exercise 19

1. The mountains are in labour; there will be brought forth a ridiculous mouse. 2. Cæsar attained a certain charm and wit unusual in our orators. 3. Wherever there is land, there is sea and air. 4. In truth how well adapted, and how serviceable in all arts, the hands that nature has given to man! 5. All our household salutes thee! 6. I speak of these things like one who is the father of a household.

1. Haec non sunt in nostra manu. 2. Romam venit cum magna manu. 3. Ea domus et patria est mihi. 4. Salus populi suprema lex esto. 5. Utrum, inquit, domum an rus ibo? 6. Astyages Harpagi filium sua manu occidit, carnemque eius coctam patri apposuit.

E. A. B.

FRENCH.—XXI

Irregular Verbs belonging to the second conjugation in **-ir** may be grouped into three classes, differentiated by their ending in the past definite. The first and most numerous class has this ending in **-is**, as **je couvris**, *I covered;* the second has it in **-us**, as **je mourus**, *I died;* and the third class modifies the stem and adds **-s**, as **je vins**, *I came*, from **venir**, *to come*.

Class 1

ACQUÉRIR, *to acquire*
Acquérir, acquérant, acquis, j'acquiers, j'acquis.

Ind. Pres.	*Imperf.*
j'acquiers	j'acquérais
il acquiert	nous acquérions
nous acquérons	etc.
ils acquièrent	
etc.	
Past Def.	*Fut.*
j'acquis	j'acquerrai
nous acquîmes	nous acquerrons
etc.	etc.
Cond. Pres.	*Imper.*
j'acquerrais	acquiers
nous acquerrions	acquérons
etc.	acquérez
Subj. Pres.	*Imperf.*
que j'acquière	que j'acquisse
qu'il acquière	que nous acquissions
que nous acquérions	etc.
qu'ils acquièrent	
etc.	

BOUILLIR, *to boil*
Bouillir, bouillant, bouilli, je bous, je bouillis.

Ind. Pres.	*Imperf.*
je bous	je bouillais
il bout	nous bouillions
nous bouillons	etc.
ils bouillent	
etc.	
Past Def.	*Fut.*
je bouillis	je bouillirai
nous bouillîmes	nous bouillirons
etc.	etc.
Cond. Pres.	*Imper.*
je bouillirais	bous
nous bouillirions	bouillons
etc.	bouillez
Subj. Pres.	*Imperf.*
que je bouille	que je bouillisse
qu'il bouille	que nous bouillissions
que nous bouillions	etc.
qu'ils bouillent	
etc.	

COUVRIR, *to cover*

Couvrir, couvrant, couvert, je couvre, je couvris.

Ind. Pres.	*Imperf.*
je couvre	je couvrais
il couvre	nous couvrions
nous couvrons	etc.
ils couvrent	
etc.	
Past Def.	*Fut.*
je couvris	je couvrirai
nous couvrîmes	nous couvrirons
etc.	etc.
Cond. Pres.	*Imper.*
je couvrirais	couvre
nous couvririons	couvrons
etc.	couvrez
Subj. Pres.	*Imperf.*
que je couvre	que je couvrisse
que nous couvrions	que nous couvrissions
etc.	etc.

CUEILLIR, *to gather*

Cueillir, cueillant, cueilli, je cueille, je cueillis.

Ind. Pres.	*Imperf.*
je cueille	je cueillais
nous cueillons	nous cueillions
ils cueillent	etc.
etc.	
Past Def.	*Fut.*
je cueillîs	je cueillerai
nous cueillîmes	nous cueillerons
etc.	etc.
Cond. Pres.	*Imper.*
je cueillerais	cueille
nous cueillerions	cueillons
etc.	cueillez
Subj. Pres.	*Imperf.*
que je cueille	que je cueillisse
que nous cueillions	que nous cueillissions
etc.	etc.

DORMIR, *to sleep*

Dormir, dormant, dormi, je dors, je dormis.

Ind. Pres.	*Imperf.*
je dors	je dormais
il dort	nous dormions
nous dormons	etc.
ils dorment	
etc.	
Past Def.	*Fut.*
je dormis	je dormirai
nous dormîmes	nous dormirons
etc.	etc.
Cond. Pres.	*Imper.*
je dormirais	dors
nous dormirions	dormons
etc.	dormez
Subj. Pres.	*Imperf.*
que je dorme	que je dormisse
que nous dormions	que nous dormissions
etc.	etc.

FAILLIR, *to fail*

Faillir, faillant, failli, (je faux), je faillis.

Ind. Pres.	*Imperf.*
(je faux)	je faillais
(tu faux)	nous faillions
(il faut)	ils faillaient
nous faillons	etc.
vous faillez	
ils faillent	
Past Def.	*Fut.*
je faillis	je faudrai
nous faillîmes	nous faudrons
etc.	etc.
Cond. Pres.	*Imper.*
je faudrais	(faille)
nous faudrions	(faillez)
etc.	
Subj. Pres.	*Imperf.*
que je faille	que je faillisse
que nous faillions	que nous faillissions
etc.	etc.

Note that the parts given within brackets are practically obsolete, and that the whole of the indicative present tense, the imperfect and future tenses, are very little used in speech or in writing.

FUIR, *to flee*

Fuir, fuyant, fui, je fuis, je fuis.

Ind. Pres.	*Imperf.*
je fuis	je fuyais
nous fuyons	nous fuyions
ils fuient	etc.
etc.	
Past Def.	*Fut.*
je fuis	je fuirai
nous fuîmes	nous fuirons
etc.	etc.
Cond. Pres.	*Imper.*
je fuirais	fuis
nous fuirions	fuyons
etc.	fuyez
Subj. Pres.	*Imperf.*
que je fuie	que je fuisse
que nous fuyions	que nous fuissions
qu'ils fuient	etc.
etc.	

VOCABULARY

accourir, *to run up* (to).
assez, *enough, tolerably.*
autrui, *others.*
correctement, *correctly.*
la dette, *the debt.*
la force, *force, strength.*
fournir, *to furnish.*
le fusil, *the gun.*
la modiste, *the dressmaker.*
l'ouvrage (m.), *the work.*
penser, *to think.*
le prêtre, *the priest.*
raconter, *to relate, tell.*

Exercise 39

1. J'irai à l'église dimanche prochain. 2. Nous haïssons les méchants. 3. Quelqu'un qui me verrait croirait que j'allais à un rendezvous d'amour ou chercher de l'argent. 4. Il faut bien que je te raconte ce que je pense et ce que je sens. 5. Peut-être me trompé-je. 6. Quand je la rencontrerai, je la reconnaîtrai. 7. Vous écrivez assez correctement. 8. Cet enfant est assez attentif. 9. A-t-il fallu beaucoup travailler pour finir l'ouvrage à temps? 10. Quand faut-il écrire à notre ami? 11. La modiste a-t-elle tout ce qu'il lui faut? 12. Ne faut-il aller trouver mon père? 13. Béni soit-il pour ce qu'il a fait. 14. Il acquiert plus de force tous les jours. 15. Je partirai demain pour l'Angleterre. 16. Je l'ai ouï dire. 17. Ne vous réjouissez pas des malheurs d'autrui. 18. Vous fournit-on des habits quand vous en avez besoin? 19. On nous dit qu'il doit avoir lieu cet après-midi. 20. Je veux vous l'envoyer si vous voulez la lire.

Exercise 40

1. What must we do to-day? 2. It has been necessary to work the whole day. 3. Does he not also need money? 4. He needs a good deal to pay his debts. 5. I can send him there every Sunday, if he likes. 6. I am willing to send it to you, if you want it. 7. We do not wish to see anyone but them. 8. My mother ran up to me, and told me that she had always been thinking of me. 9. We ran up to him when he spoke. 10. His strength fails him. 11. Have you heard of it? 12. Have you slept well? 13. The priest gave him holy bread. 14. I leave for Italy this afternoon. 15. She will come if you wish it. 16. It does not suit me to write to him. 17. Is your gun worth as much as mine? 18. Will you go to my father's? 19. I have not asked him for it. 20. What ought I to do?

Key to Exercise 35

1. It was more than two hours since vespers had finished. 2. There is not a great deal, but there is some. 3. Was it in order to see better the window of which he spoke to me? 4. There is no youth without beauty. 5. But what was certain was that she had disappeared. 6. Nothing more was said. 7. I was speaking this morning when you came in. 8. I was passing yesterday when she called me. 9. I was speaking to your father yesterday when your friend met us. 10. I had finished breakfast when he came in. 11. As soon as I had finished my task, I used to speak to my friend. 12. We go to bed at sunset. 13. I go to sleep as soon as I go to bed. 14. I awake every day at six o'clock in the morning. 15. It does not freeze; it is foggy. 16. Did those goods sell well? 17. Did your children apply themselves to study? 18. To learn a language application is necessary. 19. I must read a good book. 20. How much money does your father require?

Key to Exercise 36

1. Nous nous sommes donné de la peine. 2. Votre cousin s'est promené. 3. Nos amis se sont flattés. 4. Vos sœurs se sont-elles assises? 5. Nous nous sommes aperçus de cela. 6. Votre mère s'est-elle bien portée? 7. À qui vos sœurs se sont-elles adressées? 8. Ne se sont-elles pas trompées? 9. Nous nous y sommes ennuyés. 10. De quoi vous êtes-vous servie pour écrire, mademoiselle? 11. Je me suis servie d'une plume d'or. 12. Pleut-il ce matin? 13. Il ne pleut pas; il neige. 14. Y a-t-il plusieurs personnes chez-moi? 15. N'y a-t-il personne à l'église? 16. Fait-il froid ou chaud aujourd'hui? 17. Fait-il du vent ou du brouillard? 18. L'année dernière j'allais tous les jours à l'école. 19. Quand nous demeurions à la campagne, nous étudions toute la journée. 20. J'allais à la chasse hier matin, quand nous nous recontrâmes.

Key to Exercise 37

1. You have never heard tell of the Countess of G.? 2. You should know something about it. 3. You are going to tell me all you know about the affair. 4. Come here. We are going to chat. 5. Ah! it does not do to look closely at people's beginnings, any more for women than for nations. 6. It does not do to look closely at anybody's cradle. 7. She can be off. 8. But shall I be able to recall that story without spoiling it? 9. Before starting for the other world, I want at all events to pack my portmanteau. 10. When I am ill I send for him. 11. We have just received money. 12. I have just torn my coat. 13. Is your brother going to his friend? 14. Are you going for money? 15. I intend to go there Tuesday. 16. Are you not going to write to your acquaintances? 17. People often deceive themselves in trying to deceive others. 18. I weary of the town, and I enjoy myself in the country. 19. What do you amuse yourself with? 20. We go for a walk in the morning, and we work the rest of the day.

E. A. B.

GERMAN.—XVIII

Uses of Laſſen and the so-called Modal Auxiliaries.—Laſſen is a kind of Causative Auxiliary used in the sense of "to have a thing done": Er ließ ſich einen Trunk geben, *he caused a drink to be given to himself;* Sie läßt einen Arzt kommen, *she causes a doctor to come*, i.e. she has a doctor sent. (Note that the active infinitive after laſſen often has a passive sense.)

It is also used with an Infinitive in its proper sense of "to let or allow": Sie will mich nicht gehen laſſen, *she will not allow me to go.* Used without a following Infinitive it means "to leave or let"; it also has this meaning when followed by the verb ſein: er ließ es ſein, *he let it be*, i.e. he stopped doing it; laſſen Sie ihn, *leave* (or let) *him alone.*

Dürfen.—This has preserved its original meaning "to need" in the compound bedürfen, *to require*, but this meaning is also preserved in phrases with nur: er darf nur befehlen, *he has only to command;* Sie hätten es nur ſagen dürfen, *you need only have said it.*

Most commonly it means to be allowed: Er darf nicht leſen, *he is not allowed to read;* darf ich fragen? *may I* (be allowed to) *ask?* With a negative it is used in the sense of "must not": er darf ſich darüber nicht wundern, *he must not wonder at it.*

The Preterite Conjunctive is used to denote a strong possibility or probability: das dürfte ſchon wahr ſein, *that might well be true;* das dürfte ſchon vorgekommen ſein, *that may well have happened.*

It may be used elliptically when the Infinitive can be supplied from the context: warum tut er es nicht? Er wird es wohl nicht dürfen, *why does he not do it? He probably is not allowed to* (do it). It is also used sometimes with an adverb or adverbial phrase with a verb of motion understood: Darf ich hinein? *may I* (go) *in?*

Können.—The original meaning is "to know" or "know how," but it is mostly used in the sense of "to be able." The original meaning appears in such phrases as, er kann Deutſch, *he knows German;* er kann etwas, *he has some knowledge;* wir wollen ſehen was Sie können, *we will see what you know* (can do). The common use is illustrated by: ich kann ſchwimmen, *I can swim.*

It is also used to denote possibility: meinetwegen kann er kommen, *as far as I am concerned he may come.* It denotes possibility, especially in the Past Conjunctive: das kann ſein, *that may be;* er könnte wiederkommen, *he might return.*

It is also used elliptically as is dürfen: jeder tut was er kann, *everyone does what he can* (do); warum wollte ſie nicht ſingen? Sie kann es nicht, *why would she not sing? She cannot* (do so).

Further, it is used with a verb of motion understood in conjunction with adverbs and adverbial phrases: ſie konnte nicht von der Stelle, *she could not* (move) *from the spot;* er kann nicht hinaus, *he cannot* (get) *out.*

Mögen.—This verb has two main meanings. (1) It is used in the sense of "to be able" or "to be allowed" as the result of some concession or permission: er mag es behalten, *he may keep it;* das mag vorkommen, *that may happen;* er mag ſagen was er will, *whatever he may say,* or *let him say what he will.* (2) It has the meaning "to like," "to be fond of": ich mag ſie ſehr gern, *I am very fond of her;* ich mochte es Ihnen nicht ſagen, *I did not like to tell you;* auch ich möcht' mit dir ſterben, *I too should like to die with thee;* ich möchte ſo etwas nicht tun, *I should not like* or *I am unwilling to do such a thing;* ſie möchte wohl damals zehn Jahre alt ſein, *she might* or *must have been ten years old at that time.*

The Past Conjunctive is also used to express a wish: möchte das doch wahr ſein! *if only that were true!* It may also denote possibility or probability: daraus möchte wohl nichts werden, *most likely nothing will come of that;* man möchte närriſch werden, *it is enough to drive one mad,* i.e. one might almost become mad.

Further, it is used in final clauses (to express purpose): damit ſie nicht verhungern mögen, *so that they may not starve.* Very rarely it is used in its original sense of "to have power": keiner mag den Welträtſel ergründen, *no one is able to solve the riddle of the world.*

Müſſen.—This is used to denote necessity, and is equivalent to the English "must," "have to," "be obliged to," etc.: alle Menſchen müſſen ſterben, *all men must die;* wir mußten weiterreiſen, *we had to travel on;* er mußte ſofort nach Hauſe gehen, *he was obliged to go home at once.*

The Past Conjunctive is used in the sense of "ought": er müßte ſchon hier ſein, *he ought to be here by now.*

It has, besides, a number of more or less idiomatic uses: das mußte gerade heute paſſieren, *of course that was bound to happen to-day* (sarcastically); was muß ich hören? *what is that I hear?* (as a reproof); ſie müßte ſchon irrſinnig ſein das zu tun, *she would be mad if she did that,* or *it would be madness for her to do that;* er muß ſich wohl irren, *he is mistaken, I think;* er wird gleich hier ſein, es müßte denn etwas ſehr wichtiges vorgefallen ſein, *he will be here immediately, unless something very important has occurred;* er muß immer Recht haben, *it is his nature always to insist that he is right.*

It is used with adverbs and adverbial phrases with a verb of motion understood: ich muß fort, *I must* (go) *away;* er muß nach Berlin, *he must* (go) *to Berlin.*

Sollen retains its original meaning of duty or obligation, especially in the Preterite: er ſollte es tun, *he ought to do it;* ich hätte ſofort kommen ſollen, *I ought to have come at once.* In addition to this it denotes a command or a necessity imposed on a person (*a*) by the speaker, (*b*) by some other authority; Sie ſollen das nicht wieder tun, *you are not to do that again;* was ſoll geſchehen? *what is to be done?* er weiß nicht was er ſagen ſoll, *he does not know what he is to say.* It is often used in a kind of reported speech, that is, in making statements, not on one's own authority, but on that of some other unspecified person: er ſoll reich ſein, *he is supposed to be rich;* die Reiſen die er gemacht haben ſollte, *the journeys which he was supposed to have made.*

The Preterite is often used in Conditional clauses either with or without wenn: ſollte es regnen, werden wir nicht kommen, *should it rain we shall not come;* wenn das wahr ſein ſollte, iſt alles verloren, *if that should be true all is lost.*

It is also used idiomatically: ſollte das wahr ſein! *supposing that were true!* Was ſoll das? *what is the object of that?* It is used with adverbs and adverbial phrases with a verb of motion understood: wohin ſoll ich? *where am I* (to go)? dieſer Brief ſoll nach Berlin, *this letter is* (to go) *to Berlin.* Was ſoll ich? *what am I to do?*

Wollen.—This denotes volition, intention or choice: er will mit uns gehen, *he intends to come with us;* ſie wollen ſofort abreiſen, *they mean to go away* (travel away) *at once;* was wollen ſie haben? *what do you wish to have?*

It has a good many idiomatic uses: Sie will ihm wohl, *she wishes him well;* er will nicht daran, *he holds back* (is averse to it); er wollte umfallen, *he was ready to fall,* or *on the point of falling;* er wollte ſchon gehen als ſein Vater ins Zimmer trat, *he was about to go when his father entered the room;* er will den König geſehen haben, *he claims to have seen the king;* das Unglück wollte daß ich ihn verſäumte, *as ill luck would have it, I missed him;* wenn man dir glauben wollte, *if one were to believe you;* ſo Gott will, *please God* or *God willing;* das wolle Gott nicht, *God forbid;* das will nichts ſagen, *that is of no consequence;* es will mir ſcheinen, *it almost seems to me;* das Eſſen will mir nicht ſchmecken, *I have no appetite,* or *my food does not appeal to me;* ſollte ſie erkranken, was ich nicht hoffen will, *should she fall ill, which I trust will not be the case.* It is also used with an adverb or adverbial phrase with a verb of motion understood: Wo wollen ſie hin? *where are you going to?* er will nach Hauſe, *he wants* (to go) *home.*

Tun, *do,* which is so much used as an auxiliary in English, is never used thus in German except colloquially in some dialects, and in older, and occasionally in literary, language: die Augen täten ihm ſinken, *his eyes did close.* The English *do* is very frequently translated by machen, but not when it is used as an auxiliary.

Impersonal Verbs are used in the third person singular, either without a subject or with the subject es. These verbs may be divided into classes:

1. Verbs which describe the phenomena of the weather: es regnet, *it is raining;* es ſchneite, *it snowed;* es hat gedonnert, *it thundered.*

2. Verbs which are customarily used in the impersonal form. Such are dünken, *to seem;* gelüſten, *to desire;* gelingen, *to succeed;* hungern, *to be hungry;* dürſten, *to be thirsty;* frieren, *to freeze, feel cold;* ſchwindeln, *to be dizzy;* grauen, *to be afraid.* The verbs belonging to this second class take an accusative or dative of the person affected: mich friert, *I am cold;* mir grauet vor ihm, *I am afraid of him.*

3. Many verbs can be used impersonally. The commonest of these is geben, in the phrase es gibt, *there is, there are.* Other examples are: es geht ihm gut, *he is well* (it goes well to him); es bedarf des Geldes, *money is needed.*

4. Intransitive verbs are used reflexively or in the passive voice: es tanzt ſich hier gut, *it is pleasant to dance here;* hier wird heute muſiziert, *there is music here to-day.*

5. A good many impersonal phrases are formed by means of the verb ſein and the verb werden with adjectival or adverbial adjuncts. These relate to feelings and take a dative of the person affected: mir iſt bange, *I feel afraid;* ihm wird ſchlecht, *he feels ill;* mir iſt unheimlich zu Mute, *I feel creepy* or *uncanny* (it is uncanny to me in my mind); mir iſt als ob ich die Hände auf's Haupt dir legen ſollt', *I feel as if I should lay my hands on thy head.*

VOCABULARY

Verhältniß, s.n.2, *circumstance.*]
erzählen, w., *to tell.*
tief, *deep.*
begabt, *gifted.*
eben, *just* (adv.).
Äußerung, w.f., *utterance.*
verſtändlich, *comprehensible.*
Beſitz, s.m., *possession.*
führen, w., *to lead.*
drückend, *oppressive.*
Armut, f., *poverty.*
verlocken, w., *to tempt.*
Frevel, s.m.1, *outrage, crime.*
erleuchten, w., *to enlighten.*
abbüßen, w., *to atone for.*
Pilgerreiſe, w.f., *pilgrimage.*
rufen, s., *to call early.*
glauben, w., *to believe.*
Kenntniß, s.f.2, *knowledge.*
lebensklug, *worldly wise.*
einzeln, *single.*
ſpät, *late.*
bequem, *comfortable.*
Reichtum, s.m.3, *riches.*
herabſinken, s., *to sink down.*
bitter, *bitter.*
einſt, *once.*
verrucht, *infamous.*
Todſünde, w.f., *deadly sin.*
begehen, s., *to commit.*
Gnade, w.f, *mercy.*
heilig, *holy, sacred.*
Linde, w.f., *lime tree.*
entfernt, *distant.*
kalt, *cold.*
Preußen, *Prussia.*

Exercise 43

Nie hat mir meine Mutter geſagt[1] in welchen Verhältniſſen[2] mein Vater in der Welt lebte; rufe[3] ich mir aber alles das ins Gedächtniß zurück, was ſie mir ſchon in meiner früheſten Jugend von ihm erzählte, ſo muß ich wohl glauben daß es[4] ein mit tiefen Kenntniſſen begagter, lebenskluger Mann war. Eben aus dieſen Erzählungen und einzelnen Äußerungen meiner Mutter, über[5] ihr früheres Leben, die mir erſt ſpäter verſtändlich wurden, weiß ich daß meine Eltern von einem bequemen Leben, welches ſie im Beſitz[6] vielen Reichtums führten, herabſanken[7] in die drückendſte bitterſte Armut, und daß mein Vater, einſt durch den Satan verlockt[8] zum verruchtem Frevel, eine Todſünde beging, die er, als ihn in ſpäten Jahren die Gnade Gottes erleuchtete, abbüßen wollte[9] auf einer Pilgerreiſe nach der heiligen Linde im weit entfernten kalten Preußen.

NOTES:

(1) hat geſagt—a typical case in which the German Perfect is used as a past tense which must be translated by the simple Past in English. (2) Verähltniß in the singular properly

means *relation*, but in the plural it usually means *circumstances*. (3) rufe ich—the inverted order denotes a conditional clause. (4) es, the impersonal pronoun, used instead of the personal, like the French use of *ce* in *c'était un homme*. (5) über depends on Äußerungen, as we say *utterances about*. (6) im Beſitz, *in the possession* of, i.e. thanks to the possession of. (7) herabſanken—the normal position of this would be right at the end of the clause, i.e. after Armut just as the verb of the co-ordinate noun clause, beging, is placed at the end. (8) verlockt—here again the normal position would be after Frevel, but the above was written more than a hundred years ago. (9) abbüßen wollte—this also one would expect to find at the end of the clause, but a certain amount of licence is allowed, especially when, as here, there are a number of dependent clauses.

VOCABULARY

wage war, Krieg, s.m.2, führen, w.
Rome, Rom.
camp, Lager, s.n.1.
opposite, gegenüber, gov. dat.
doctor, Arzt, s.m.2.
before, bei.
reward, Belohnung, w.f.
ready, bereit.
bind, in Bande legen, w.
master, Herr, w.m.
plan, Plan, s.m.2.
against, wider.
admiration, Bewunderung, w.f.
action, Handlung, w.f.
exclaim, ausrufen, s.(sep.).
recognise, erkennen, w.
divert, ablenken, w. (sep.).
course, Bahn, w.f.
path, Pfad, s.m.2.
against, mit.
send out, ausſchicken, w. (sep.).
to be pitched, ſtehen, s.
appear, erſcheinen, s.
latter, letzterer.
declare, erklären, w.
for, gegen.
poison, vergiften, w.
take back, zurückführen, w. (sep.).
inform, ſagen, w., gov. dat.
make, machen, w.
full of, voll.
at, über.
on the part of, use the gen. of the def. art.
sooner, eher.
from, aus.
than, als.
integrity, Rechtſchaffenheit, w.f.

Exercise 44

PYRRHUS AND FABRICIUS

Pyrrhus, king of Epirus, was waging[1] war against Rome; Fabricius was sent out to meet[2] him. Now[3] when his camp and the king's were pitched opposite each other[4], the latter's doctor appeared in the night before Fabricius and declared himself ready for a reward to poison Pyrrhus. Fabricius had this man bound[5], sent back to his master, and had the latter informed[6] what plans the doctor had made against his life. Full of admiration at this action on the part[7] of Fabricius, the king is supposed[8] to have exclaimed: "In this[9] I recognise Fabricius! The sun might sooner be diverted from its course than this man from the path of integrity."

NOTES:

(1) Was waging—simple preterite. (2) to meet him; say, against (gegen) him. (3) when now his and the king's camps. (4) each other—ſich, dat. gov. by gegenüber. (5) had bound, etc.; *had* must here be translated by laſſen, followed by the active infinitive (see early part of this lesson). (6) had informed; laſſen need not be repeated. (7) on the part of, des. (8) is supposed; use ſollen (see earlier part of this lesson). (9) in this, daran.

Key to Exercise 41

THE GLOVE

King Franz sat before his Lion Garden awaiting the combat, and with him the high court officials, and round about on a high balcony the ladies in a lovely circle.

And he (makes a sign with his finger) beckons, the spacious den opens, and a lion walks in with measured tread, and in silence he looks round with a protracted yawn, and shakes his mane and stretches his limbs, and lies down.

And the king beckons again; thereupon a second door opens quickly, thence rushes forth with a wild leap a tiger. As he espies the lion he roars loudly, curves his tail horribly (makes with his tail a horrible hoop) and stretches out his tongue, and nervously he walks round the lion, growling wrathfully, then grumbling he lies down at the side.

And the king beckons again; then from two open doors of the house two leopards spring forth at the same time (then the doubly opened house vomits forth two leopards at the same time). These filled with the lust of battle (with courageous lust for battle), fling themselves upon the tiger; it seizes them with its terrible claws, and the lion, with a roar, stands up—then all grows still; and round about in a circle the horrible cats, burning with the desire of blood (murder), lie down.

Then there falls from the edge of the gallery a glove dropped by (from) a beautiful hand right in the midst between the tiger and the lion. And Lady Kunigunde turns mockingly to the Knight Delorges: "Sir Knight, if your love is as ardent as you always (at every time) swear to me it is, why, then, pick up the glove for me."

And the knight quickly descends into the terrible den with a firm step, and from amid the monsters he picks up the glove boldly (with a bold finger).

And with astonishment and with horror the knights and ladies see it; and coolly he brings back the glove. Then his praises are sounded by all lips (his praise sounds to him out of every mouth), but with a tender look of love—it promises him his approaching happiness—Lady Kunigunde receives him. And he throws the glove in her face: "Your thanks, lady, I do not desire!" and shuns (leaves) her from that moment.

Key to Exercise 42

Die Prinzeſſin und die Erbſe (Fortſetzung)

„Ach! das werden wir bald herausfinden," dachte die alte Königin; „aber ſie ſagte nichts, ging in das Schlafzimmer hinein, nahm alle Sachen vom Bette ab, und legte eine Erbſe auf eine der Latten. Dann legte ſie zwanzig Matratzen auf die Erbſe und zwanzig Federbetten auf die Matratzen. Dort ſollte die Prinzeſſin jene Nacht ſchlafen. Des Morgens fragten ſie ſie wie ſie geſchlafen hätte."

„Ach, ſchrecklich ſchlecht!" ſagte ſie. „Ich habe die ganze Nacht kaum ein Auge zugetan. Der Himmel allein weiß was da in dem Bett war! Ich habe auf etwas hartem gelegen, das mich am ganzen Körper braun und blau gemacht ha'. Es iſt etwas furchtbares." Es war nun klar daß ſie eine wirkliche Prinzeſſin ſei, da ſie die Erbſe durch zwanzig Matratzen und zwanzig Federbetten gefühlt hatte. Nur eine wirkliche Prinzeſſin konnte ſo empfindlich ſein. Der Prinz heiratete ſie alſo, denn er wußte daß hier eine wirkliche Prinzeſſin ſei; und die Erbſe wurde in ein Muſeum geſtellt, wo man ſie noch ſehen kann, wenn keiner ſie fortgenommen hat. Dies iſt nun wirklich eine wahre Geſchichte.

M. A. L.

RUSSIAN.—IX

The Noun

91. *The Plural of Neuter Nouns* is marked by the following endings:

Nominative	-а	-я	*Accusative*	-а	-я
Genitive	-ъ	-ей	*Instrumental*	-ами	-ями
Dative	-амъ	-ямъ	*Prepositional*	-ахъ	-яхъ

(*See* following Table G.)

92. *Table G. Full declension of Neuter Plural.*

VOCABULARY

Во всѣхъ	(va vsyekh),	*in all.*
Считáться	(s-chi-tát'-sya),	*to reckon with.*
Отпрáвить	(at-prá-vit'),	*to expedite, send off.*
Рáньше	(rán'-she),	*before, earlier.*
Употреблять	(u-pa-treb-lyat'),	*to use.*
Кóлкихъ	(kól-kikh),	*pricking, sarcastic.*
Пóльзоваться	(pól'-zo-vat'-sya),	*make use of, enjoy.*
Телефóнъ	(tye-lye-phón),	*telephone.*
Съ удовóльствіемъ	(s-uda-vól'-stvi-yem),	*with pleasure.*
Нѣкоторыя	(nié-ko-to-rü-ya),	*some.*

Original - -	Слóво, *the word, promise.*	Пóле, *field, margin.*
Nominative - -	Слова́, *the words, promises.*	Поля́, *fields, margins.*
Genitive - -	Словъ, *of the words, promises.*	Полéй, *of fields, margins.*
Dative - - -	Слова́мъ, *to the words, promises.*	Поля́мъ, *to fields, margins.*
Accusative - -	Слова́, *the words, promise .*	Поля́, *fields, margins.*
Instrumental - -	Слова́ми, *with the words, promises.*	Поля́ми, *with fields, margins.*
Prepositional - -	Въ слова́хъ, *in the words, promises.*	На поля́хъ, *on fields, margins.*

93. The Nouns сукнó, *cloth ;* окнó, *a window ;* стеклó, *a pane*—are amplified to -онъ in Genitive Plural and are declined as follows :

Скóлько угóдно	(skól'-ko u-gód-no),	*as long (much) as you please.*
Отсýтствіе	(at-sút-stvi-ye),	*absence.*
Завéдывать	(za-vyé-dü-vat'),	*to administer to.*
Дать	(dat'),	*to give.*

Nominative.	*Genitive.*	*Dative.*	*Accusative.*	*Instrumental.*	*Prepositional.*
Сýкна	Сукóнъ	Сукнáмъ	Сýкна	Сукнáми	О сукнáхъ
Óкна	Óконъ	Óкнамъ	Óкна	Óкнами	Объ óкнахъ
Стéкла	Стéколъ	Стéкламъ	Стéкла	Стéклами	На стéклахъ

94. The Nouns сѣдлó, *a saddle ;* ремеслó, *a handiwork, craft ;* числó, *a number,* бревнó, *a beam, joist ;* зернó, *a grain of corn ;* полотнó, *linen, sheet ;* пятнó, *a spot, stain ;* ведрó, *a bucket ;* ядрó, *a kernel, bullet,* are amplified to -елъ, -енъ, -еръ in Genitive Plural, as shown below :

Сношéніе	(sna-shé-ni-ye),	*connection.*
Лицё	(li-tsó),	*face, appearance.*
Многочúсленны	(mno-go-chís-lyen-nü),	*are numerous.*
За	(za),	*for, to fetch.*
Всё ещё	(vsyo yesh-chó),	*still.*
По той же сáмой	(pa toĭ zhe sá-moĭ),	*in the same.*
Милліóнъ	(mil-lión),	*million.*

Nominative.	*Genitive.*	*Dative.*	*Accusative.*	*Instrumental.*	*Prepositional.*
Сѣдла	Сѣделъ	Сѣдламъ	Сѣдла	Сѣдлами	О сѣдлахъ
Ремёсла	Ремёселъ	Ремёсламъ	Ремёсла	Ремёслами	О ремёслахъ
Чúсла	Чúселъ	Чúсламъ	Чúсла	Чúслами	О чúслахъ
Брёвна	Брёвенъ	Брёвнамъ	Брёвна	Брёвнами	О брёвнахъ
Зёрна	Зёренъ	Зёрнамъ	Зёрна	Зёрнами	О зёрнахъ
Полóтна	Полóтенъ	Полóтнамъ	Полóтна	Полóтнами	О полóтнахъ
Пя́тна	Пя́тенъ	Пя́тнамъ	Пя́тна	Пя́тнами	О пя́тнахъ
Вёдра	Вёдеръ	Вёдрамъ	Вёдра	Вёдрами	О вёдрахъ
Я́дра	Я́деръ	Я́драмъ	Я́дра	Я́драми	О я́драхъ

N.B.—In plural of сѣдлó the ѣ is pronounced ё (*yo*).

95. The Nouns крылó, *a wing ;* звенó, *a link ;* перó, *a pen,* are declined as follows :

Составля́ться	(sa-stav-lyát'-sya),	*to be built up.*
Казначéйство	(kaz-na-chéĭ-stvo),	*the treasury.*
Нарóднаго	(na-ród-na-go),	*of the national.*

Nominative.	*Genitive.*	*Dative.*	*Accusative.*	*Instrumental.*	*Prepositional.*
Крúлья	Крúльевъ	Крúльямъ	Крúлья	Крúльями	О крúльяхъ
Звéнья	Звéньевъ	Звéньямъ	Звéнья	Звéньями	О звéньяхъ
Пéрья	Пéрьевъ	Пéрьямъ	Пéрья	Пéрьями	О пéрьяхъ

96. Nouns ending in -ще are declined as if they ended in -що and follow the rule 92 for "Сло́во."

Example: Учи́лище, *a school.*

Трудолю́біе	(tru-do-lyú-bi-ye),	*industry.*
До́лгое вре́мя	(dól-go-ye vré-mya),	*for a long period.*
Че́стно	(chést-no),	*fairly, honestly.*

Nominative.	*Genitive.*	*Dative.*	*Accusative.*	*Instrumental.*	*Prepositional.*
Учи́лища	Учи́лищъ	Учи́лищамъ	Учи́лища	Учи́лищами	Въ учи́лищахъ

97. Nouns ending in **-ie** have **-ій** in Genitive Plural and are declined as shown below:

Example: Зда́ніе, *a building.*

Благоро́дно	(bla-ga-ród-no),	*nobly.*
Полага́ться	(pa-la-gát'-sya),	*to rely.*
Оста́ться	(a-stát'-sya),	*to remain.*
Про́сто	(prós-to),	*simply.*
Скро́мно	(skróm-no),	*modestly, moderately.*

Nominative.	*Genitive.*	*Dative.*	*Accusative.*	*Instrumental.*	*Prepositional.*
Зда́нія	Зда́ній	Зда́ніямъ	Зда́нія	Зда́ніями	Въ зда́ніяхъ

98. Neuter Nouns borrowed from French and other languages remain unchanged in all cases of Singular and Plural. Such are:

Пальто́ (French: Paletot), *an overcoat.*
Ландо́ (German: Landau), *a landau.*
Ге́тто, *the Ghetto.*
Ко́фе, *coffee.*
Желе́ (French: la gelée), *jelly.*
Ве́то, *the veto.*
Меню́, *the menu.*
Пари́, *a bet.*

99. The Nouns не́бо, *heaven*, and чу́до, *a miracle*, are declined as follows:

Nominative.	*Genitive.*	*Dative.*	*Accusative.*	*Instrumental.*	*Prepositional.*
Небеса́	Небе́съ	Небеса́мъ	Небеса́	Небеса́ми	Въ небеса́хъ
Чудеса́	Чуде́съ	Чудеса́мъ	Чудеса́	Чудеса́ми	О чудеса́хъ

The Verb

100. Conjugation of Irregular Verbs.

Пра́мо	(pryá-mo),	*direct.*
Аме́рика	(a-mé-ri-ka),	*America.*
Почёт	(pa-chót),	*respect.*
Поря́докъ	(pa-ryá-dok),	*order, system.*

(To be continued.)

Practice XXII

(*a*) Change the following Genitives Plural into Genitives Singular:

Су́конъ, стёколъ, ремёселъ, чи́сель,
зе́ренъ, вёдеръ, кры́льевъ, пе́рьевъ,
пя́тенъ, поло́тенъ небе́съ, чуде́съ.

(*b*) Express the following in the Genitive Plural:

Сокро́вище, *a treasure.* Дѣ́йствіе, *an action.*

INFINITIVE			
Мочь, *to be able, can, may.*	Жить, *to live.*	Итти́, *to go.*	Вести́, *to conduct.*
PRESENT TENSE, SINGULAR			
1. Я могу́, *I can.*	Я живу́, *I live.*	Я иду́, *I go.*	Я веду́, *I conduct.*
2. Ты мо́жешь, *thou canst.*	Ты живёшь, *thou livest.*	Ты идёшь, *thou goest.*	Ты ведёшь, *thou conductest.*
3. Онъ мо́жетъ, *he can.*	Онъ живётъ, *he lives.*	Онъ идётъ, *he goes.*	Онъ ведётъ, *he conducts.*
3. Она́ мо́жетъ, *she can.*	Она́ живётъ, *she lives.*	Она́ идётъ, *she goes.*	Она́ ведётъ, *she conducts.*
3. Оно́ мо́жетъ, *it can.*	Оно́ живётъ, *it lives.*	Оно́ идётъ, *it goes.*	Оно́ ведётъ, *it conducts.*
PLURAL			
1. Мы мо́жемъ, *we can.*	Мы живёмъ, *we live.*	Мы идёмъ, *we go.*	Мы ведёмъ, *we conduct.*
2. Вы мо́жете, *you can.*	Вы живёте, *you live.*	Вы идёте, *you go.*	Вы ведёте, *you conduct.*
3. Они́ мо́гутъ, *they can.*	Они́ живу́тъ, *they live.*	Они́ иду́тъ, *they go.*	Они́ веду́тъ, *they conduct.*
3. Онѣ́ мо́гутъ, *they can*, f.	Онѣ́ живу́тъ, *they live*, f.	Онѣ́ иду́тъ, *they go*, f.	Онѣ́ веду́тъ, *they conduct*, f.
3. Они́ мо́гутъ, *they can*, n.	Они́ живу́тъ, *they live*, n.	Они́ иду́тъ, *they go*, n.	Они́ веду́тъ, *they conduct*, n

IMPERATIVE

Моги́, *may !* Sing.	Живи́, *live !* Sing.	Иди́, *go !* Sing.	Веди́, *conduct !* Sing.
Моги́те, *may !* Plur.	Живи́те, *tive !* Plur.	Иди́те, *go !* Plur.	Веди́те, *conduct !* Plur.
Пусть онъ, она́, оно́, живётъ, } *let him, her, it, live !*	Живёмъ-ка, *let us live.*	Идёмъ-ка, *let us go.*	Ведёмъ-ка, *let us conduct.*
Пусть они́, онѣ́, они́, живу́тъ, } *let them live.*		Пусть онъ, она́, оно́, идётъ, } *let him, her, it, go !*	Пусть онъ, она́, оно́, ведётъ, } *let him, her, it conduct !*
		Пусть они́, онѣ́, они́, иду́тъ, } *let them go.*	Пусть они́, онѣ́, они́, веду́тъ, } *let them conduct.*

PAST TENSE, SINGULAR

1. Я могъ, m. Я могла́, f. Я могло́, n. } *I could.*	1. Я жилъ, m. Я жила́, f. Я жило́, n. } *I lived.*	1. Я шёлъ, m. Я шла, f. Я шло, n. } *I went.*	1. Я вёлъ, m. Я вела́, f. Я вело́, f. } *I conducted.*
2. Ты могъ, m. Ты могла́, f. Ты могло́, n. } *thou couldst.*	2. Ты жилъ, m. Ты жила́, f. Ты жило́, n. } *thou livedst.*	2. Ты шёлъ, m. Ты шла, f. Ты шло, n. } *thou wentest.*	2. Ты вёлъ, m. Ты вела́, f. Ты вело́, n. } *thou conductedst.*
3. Онъ могъ, *he could.* Она́ могла́, *she could.* Оно́ могло́, *it could.*	3. Онъ жилъ, *he lived.* Она́ жила́, *she lived.* Оно́ жило́, *it lived.*	3. Онъ шёлъ, *he went.* Она́ шла, *she went.* Оно́ шло, *it went.*	3. Онъ вёлъ, *he conducted.* Она́ вела́, *she conducted.* Оно́ вело́, *it conducted.*

PLURAL

1. Мы могли́, *we could.*	1. Мы жи́ли, *we lived.*	1. Мы шли, *we went.*	1. Мы вели́, *we conducted.*
2. Вы могли́, *you could.*	2. Вы жи́ли, *you lived.*	2. Вы шли, *you went.*	2. Вы вели́, *you conducted.*
3. Они́, m. Онѣ́, f. могли́, Они́, n. } *they could.*	3. Они́, m. Онѣ́, f. жи́ли Они́, n. } *they lived.*	3. Они́, m. Онѣ́, f. шли Они́, n. } *they went.*	3. Они́, m. Онѣ́, f. вели́, Они́, n. } *they conducted.*

Note: The future tense of the above verbs is formed in accordance with Rule 90.

(To be continued.)

(*b*) Express in the Genitive Plural (*continued*):

Жи́лище, *a dwelling.*
Храни́лище, *a depository.*
Выраже́ніе, *an expression.*
Впечатлѣ́ніе, *an impression.*
Свѣ́дѣніе, *an information, knowledge.*
Жела́ніе, *a wish.*

(*c*) Express the following in Prepositional Singular with the preposition **въ**, *in*:

Мѣ́сто, *a place.*
Госуда́рство, *a state, country.*
Обстоя́тельство, *a circumstance.*
О́бщество, *a society.*
Приказа́ніе, *an order, command.*
Сообще́ніе, *a communication.*

(*d*) Express the following in Dative Plural with the preposition **по**, *by, according to*:

Ка́чество, *quality.*
Досто́инство, *merit, value.*
Сво́йство, *property.*
Мнѣ́ніе, *opinion.*
Донесе́ніе, *report.*

Exercise 14

Translate the following into English:

1. На́ши су́дна иду́тъ во всѣхъ государствахъ.
2. Я не одобря́ю э́тихъ (of these) дѣ́йствій.
3. Жаль, что не считаетесь съ обстоя́тельствами.
4. Я не могъ отпра́вить това́ра ра́ньше.
5. Не употребля́йте ко́лкихъ выраже́ній въ пи́сьмахъ.
6. Могу́ ли я по́льзоваться Ва́шимъ телефо́номъ?
7. Съ удово́льствіемъ. По́льзуйтесь ско́лько уго́дно.
8. Кто ведётъ Ва́ше дѣ́ло въ Ва́шемъ отсу́тствіи?
9. Мой братъ тогда́ (then) завѣ́дываетъ дѣла́ми.
10. Мо́жете ли Вы мнѣ дать нѣ́которыя свѣ́дѣнія о фи́ркѣ Д.
11. Мы не имѣ́емъ сноше́ній съ э́той фи́ркой.
12. Това́ръ лицо́мъ продаётся.
13. Сво́йства бума́ги многочи́сленны.
14. Не вѣ́рьте донесе́ніямъ (denunciations).
15. Почему́ не иде́те за ча́емъ?
16. Я шёлъ за нимъ (it).
17. Гдѣ Вы живёте?
18. Мы всё ещё живём по той же са́мой у́лицѣ.

Exercise 15

Translate the following into Russian:

1. We lived for a long time in Paris.
2. I saw him (его́) when he went on 'Change.
3. Our warehouse has five windows.
4. Our cloths have no spots.
5. Conduct your affairs honestly and nobly (uprightly).
6. Where did you go this (сего́дня) morning?
7. I went to fetch a cup (за ча́шкой) of coffee.
8. Where is my overcoat?
9. It was left in the landau.
10. Do not rely on miracles.
11. We live simply and modestly.
12. I do not like sarcastic expressions.
13. I receive information (Plural) direct from America.
14. We cannot satisfy all wishes.
15. We have branches in several (нѣсколькихъ) places.
16. He enjoys (instrumental) great respect in society.
17. I thank you for the communications.
18. Why do you not carry out (выполня́ть) the orders (commands)?
19. You are conducting your affairs without order.
20. It is not your business (дѣ́ло). Mind your own business.

A. C.

From the Picture by A. W. Bayes.

THE PILGRIM FATHERS WATCHING THE RECEDING OF THE *MAYFLOWER*,

the good ship which, in 1620, after a voyage of sixty-three days, landed on the shores of the newly discovered Continent of America one hundred refugees from religious persecution in England. Half their number perished from privation during their first winter in an inhospitable land. Their enterprise, however, was the beginning of New England and of the wealth and prosperity of North America.

Continued from page 230.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

NORTH AMERICA.—I

GENERALLY speaking, the continent of North America is a triangular extent of land lying between 20° and 170° west longitude and from 9° north latitude to within a few degrees of the North Pole, if we include the adjacent islands. The great continent tapers from north to south, and its boundaries are, on the north the Arctic Ocean, on the east the Atlantic, on the west the Pacific, and on the south the isthmus of Panama.

For the purposes of this course we shall consider that the southern boundary of North America is at the frontier between Mexico and Guatemala with British Honduras, as the more southerly countries have been dealt with under Central America.

The greatest length of the continent is about 4,000 miles, the greatest breadth is 3,200 miles and the area (including Greenland and the islands adjacent to the continent) some 9,300,000 square miles. Owing to the large area of high mountains and plateaux the average elevation of the entire continent is about 2,300 feet—about twice as high as that of Europe.

Physical Divisions

North America may be physically divided into four natural areas: (i.) the region of Hudson Bay and the Great Lakes, (ii.) the Eastern Highlands, (iii.) The Mississippi Valley and the Great Plains, and (iv.) The Cordilleras.

(i.) The region of Hudson Bay and the Great Lakes comprises the greater part of Canada east of the Rocky Mountains. It is for the most part of an undulating character, the visible rocks showing evidence of ice action, and the drainage being of a very indefinite nature. In the case of Reindeer Lake, for instance, in the province of Saskatchewan, the waters empty themselves in two opposite directions, part flowing southwards and finding an exit eventually into Hudson Bay, and part flowing northward through Great Slave Lake and the Mackenzie River to the Arctic Ocean.

The Great Lakes themselves form part of the basin of the St. Lawrence River. They are five in number: Lakes Superior, Michigan, Huron, Erie and Ontario. With the exception of Lake Michigan, which is entirely in the United States, these lie between the United States and the Dominion of Canada, and they are drained north-eastward by the St. Lawrence River into the Atlantic Ocean.

The Great Lakes

Their total area is over 90,000 square miles, and they fall from Lake Superior at 600 feet above the sea to Ontario 250 feet above sea level. Between Lakes Erie and Ontario are the famous falls of Niagara. These lakes comprise the largest sheets of fresh water in the world, Lake Superior being the largest in area. Although frozen for four or five months of the year they form a highly convenient means of transportation in a region that is enormously productive in mineral and vegetable wealth.

But besides these well-known lakes there are in Canada the lakes of Athabasca, Great Slave, Great Bear, Winnipeg, Winnipegosis and wellnigh countless others, many of very large size.

The country to the west of the Great Lakes and Hudson Bay up to the Rocky Mountains is, as far as the southern portions are concerned, more or less a continuation of the prairie plains of the United States. But from the 55th parallel of latitude the drainage of the region is northward and the country passes into an afforested region until, still farther north, it merges into the "Barren Lands" and a frozen morass like the tundra of Siberia.

The soil of the region of the Great Lakes, or more accurately of that region lying between the international boundary and the 60th parallel between the Hudson Bay and the base of the Rocky Mountains, is mainly

alluvial and glacial in origin. In its vast extent are rich expanses of fertile prairie now growing wheat and other cereals and almost devoid of forest, though in other parts of the "North-West Territories" there are abundant forests of spruce, fir, etc.

Hudson Bay itself has an area of about half a million square miles and is almost entirely surrounded by land. The strait to the north giving access to the Atlantic Ocean is frozen for a few months of the year, but the bay itself, except for about ten miles from the shore, is never covered with ice.

Eastern Highlands

(ii.) The Eastern Highlands may be considered as divided into two regions: a northern region stretching along the coast of Canada from Quebec province through Labrador, Baffin Land and perhaps even farther northward, and a southern region following more or less the direction of the coast of the United States. The rocks comprising these Eastern Highlands are of very ancient geological formation, and it is doubtful in some cases if they are to be considered as perhaps the oldest of stratified rocks or as volcanic and metamorphic.

The two main divisions of the Eastern Highlands are separated by the basin of the St. Lawrence River. The mountains to the north of this dividing line are known as the Laurentide Mountains or Laurentian Highlands, as they only attain a general elevation of fifteen to sixteen hundred feet. These mountains consist of very ancient rocks, geologically speaking, but have been worn down or eroded probably for some thousands of feet.

The Laurentians run parallel to the River St. Lawrence from about the level of Montreal to the coast of Labrador. To the north, along the Labrador coast and as far as Hudson Strait, the ground becomes higher and true mountains are found of about 8,000 feet in elevation. But the country is largely ice-covered and inhospitable, and as yet but partially explored. To the north of the Hudson Strait the high ground extends into the little known Baffin Land, and there probably attains an even higher elevation.

To the south of the St. Lawrence River the Eastern Highlands consist of the mountains of New Brunswick and Maine, the White Mountains, the Green Mountains, the Adirondacks and the Allegheny Mountains. The whole of this mountain system is included in the term Appalachian Mountains.

This system of mountains then comprises a series of narrow ridges separated by trough-like valleys, having a length of some 1,500 miles and a width varying from 50 to 140 miles. The most mountainous portion is in the south, in the states of Carolina and Tennessee, and this culminates in Mt. Mitchell, 6,700 feet high. Northward the range decreases in height, until in Pennsylvania and New Jersey the general elevation is only about 2,000 feet. The rocks composing the Appalachians are of great geological age and are very much folded, wrinkled and faulted, the alternation of hard and soft rocks giving very beautiful scenery in many parts. There is, however, very little of the stern and rugged appearance we are used to consider as typical of a mountain district, as the valleys and even the steep hillsides are now cultivated, and the forests that once covered them have been cut down.

The northern hills of New England have more gently rounded outlines, though in the White Mountains of New Hampshire we find more rugged features. Mount Washington, 6,200 feet high, is a very beautiful peak, and there are other summits in the neighbourhood which is rich in natural beauty and has made the district of the White and the Green Mountains a popular region for recreation, such as in our own country we find in the Lake district and North Wales.

In the woods that abound in the lower regions of these hills are found pine and spruce, hemlock, larch, etc., among the conifers, and maple, beech, oak, birch among the deciduous trees.

Valley of the Mississippi

(iii.) The Mississippi Valley and the Great Plains are composed of stratified rocks varying in age from the Palaeozoic to the Tertiary periods. This region lies between the Eastern Highlands and the Cordilleras and varies in height from the low plains round the coasts of the Gulf of Mexico to 6,000 feet at the base of the Rocky Mountains. A plain similar in character borders the Atlantic coast to the east of the Allegheny Mountains and extends into the coralliferous limestone peninsula of Florida.

Generally speaking the chief characteristics of this great continental drainage system are its low elevation and the absence of important hills having a mountainous structure. Usually the rocks comprising it are horizontally stratified deposits of marine origin and the river valleys are shallow and broad. It may, for the sake of convenience, be divided into two portions, namely, the

The greatest length of North America is about 4,000 miles, the greatest breadth about 3,200 miles; whilst the area (including Greenland and adjacent islands) is about 9,300,000 square miles. The average elevation is some 2,300 ft., about twice as great as that of Europe.

Gulf slope which drains into the Gulf of Mexico and the St. Lawrence slope draining eastward into the Atlantic.

The Gulf Plains

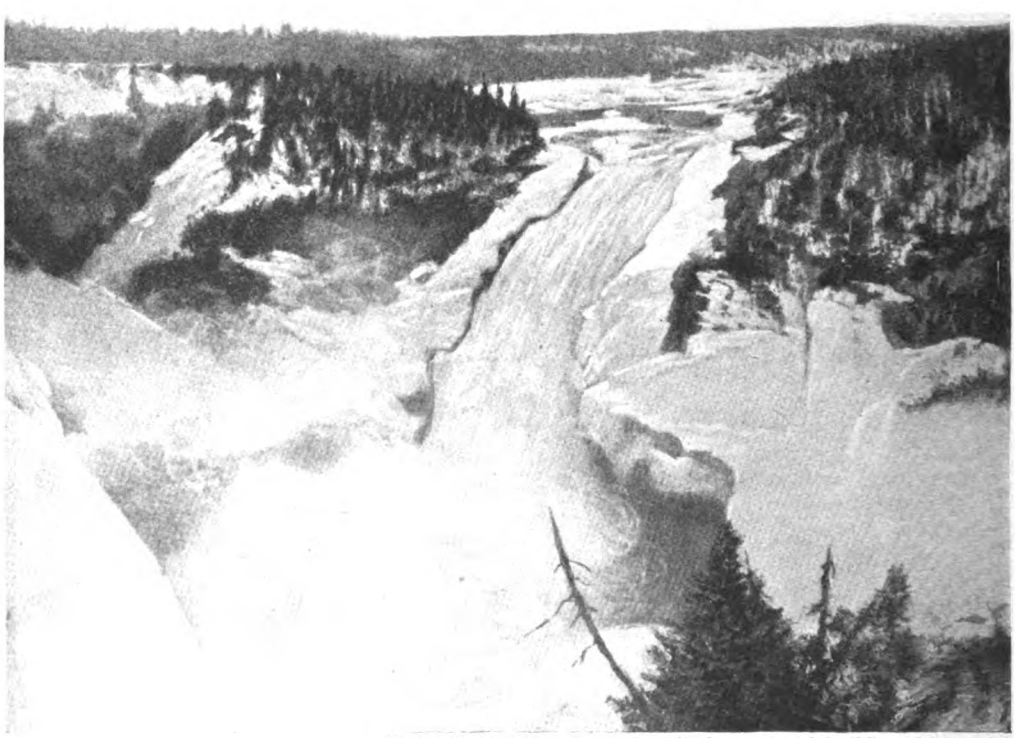
That part of the basin draining southwards consists of the Gulf Plains, the lowest lying tracts of land skirting the Gulf of Mexico in a continuous belt varying from 50 to 100 miles wide and extending from the southern extremity of Mexico in a huge and nearly complete circle round the Gulf into Florida, the greater portion of which state may be considered as part of this feature. The soil is enormously fertile, and on it can be grown corn, cotton, rice and sugar. In the Mexican portion of this region tropical fruits in addition can be raised.

In the states of Mississippi and Louisiana the Gulf Plain region attains its broadest development, extending northwards in a tapering fashion to the mouth of the Ohio River. This, the lower Mississippi basin, is due to the deposits of silt and mud brought down by the river, and much of the land is really the delta of the river.

The Gulf Plains are all below an elevation of 500 feet, and the belt actually bordering the sea is a low and swampy jungle, though it has been drained and cleared of its rank vegetation to a great extent since it was settled by Europeans. In this region are still found the Southern Pine, the staple of an important lumber industry, tulip trees, magnolia, cypress, etc. The dwarf palmetto is very characteristic, especially in Florida.

From Mexico to Ohio

The west-central portions of the continental basin consist of the Prairie Plains, a rolling, undulating or hilly region clothed with grass and other such vegetation. They extend from the Rio Grande River in Mexico and run through Texas, Kansas, Illinois,



Photo; Dr. A. P. Low; reproduced by the courtesy of the Editor of "Canada."

GREATER THAN NIAGARA.

The Grand Fall on the Hamilton River, Labrador, is far greater and finer than the more famous Niagara which falls over only about half the height. The Labrador Fall is still more or less shrouded in mystery, being known—owing to its inaccessibility—to very few white men.

etc., to Ohio. This is the region of pasture and grain fields, one of the most productive of its kind in the whole of North America. Mile after mile of corn fields, green in summer and golden in autumn, form the chief feature of the landscape. From north to south the prairie plains extend not far short of 2,000 miles and their area is about half a million square miles. The most productive portions of the wheat lands lie in the states of Minnesota and Dakota. In the south cotton is perhaps the chief crop.

To the west of the prairie plains and gradually merging from them are the Great Plateaux. These are not essentially different from the lower plains, except that in their greater elevation (they rise in parts to a greater height than the Appalachian mountain system of the east) they experience less precipitation of moisture. In spring they are carpeted with green, but as the summer heat and dryness advance they become dried up and brown.

The Great Plateaux begin south of the Rio Grande in Mexico and extend northward far into Canada. In length they may be considered as from two to two and a half thousand miles and of an average width of 300 miles, their area being some three-quarters of a million square miles. There is naturally much variety in the climate owing to their great extension in latitude. In many parts these plateaux have been deeply cut and grooved by rivers, especially in Texas, New Mexico and Oklahoma.

The valley plains of New Mexico measure from ten to twenty miles in width, and sometimes they reach a hundred miles in length.

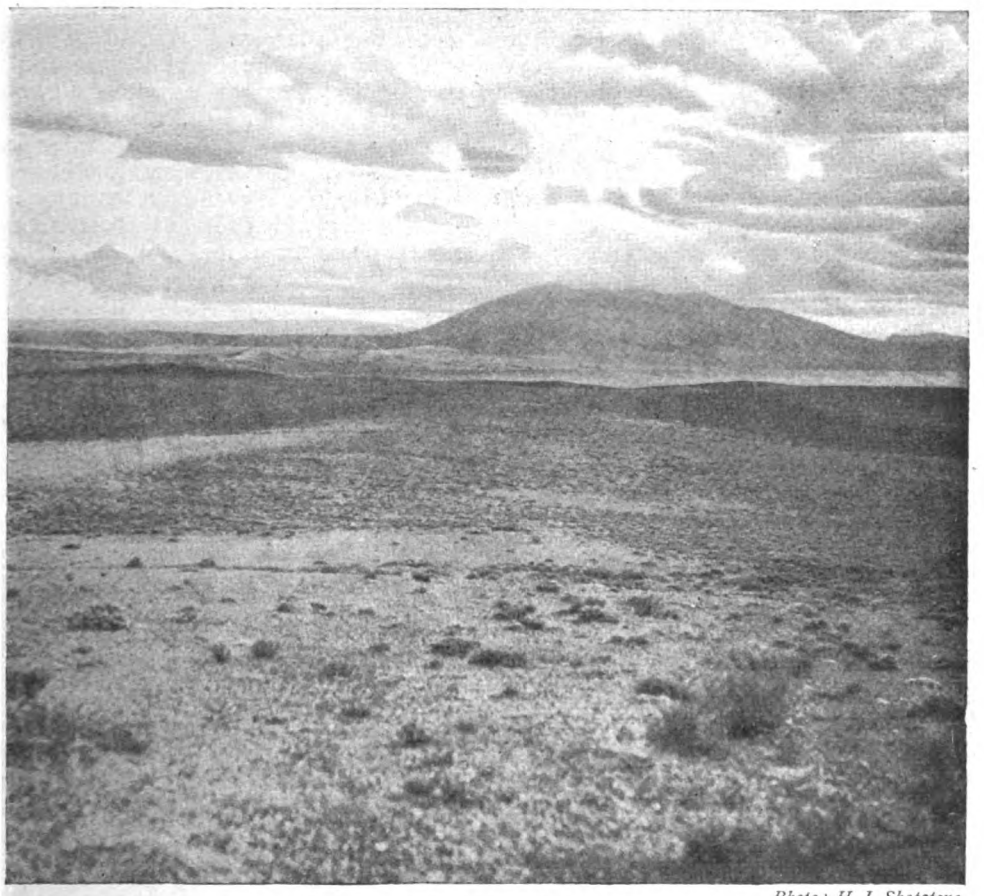


Photo: H. J. Shepstone.

ON THE PRAIRIE.

This undulating country clotted with grass and other such vegetation extends from the Rio Grande River in Mexico, through Texas, Kansas, Illinois, to Ohio. From south to north the distance is not far short of 2,000 miles, and the area about half a million square miles. This region is one of the most productive of its kind in the whole of North America.

Huge and lofty mountains rise from either side like grey walls of grey and brown rock.

In many of these plains or "bolsons" (*purses*) as they are called by the Spaniards, ephemeral lakes are formed. These are caused by the waters collecting during the rainy seasons, and they stand for several months. The waters contain very often in solution alkali or salt, and on evaporating leave a thin white coating on the river bed.

El Llano Estacado

A typical portion of this great plateau region situated in Mexico and Texas is known as El Llano Estacado (The Staked Plains). It is bordered on all sides by steep escarpments leading down into the adjacent valleys. Its surface is smooth and nearly horizontal and is clothed with Bunch grass. It is here that the great herds of buffalo which once inhabited the plateaux made their winter quarters. On account of the absence of water this enormous barren region, 500 miles from north to south and nearly 300 miles from east to west, was formerly dreaded even by experienced travellers of the plains, but water has been found in various places and the district is likely to become favourable for cattle raising.

In the northern portion of the great plateaux occur the "Bad Lands," a desert region eroded by rains, winds and streams into a wonderful array of sculptured forms. The intense heat, choking alkaline dust, and absence of water render this region unfit for the farmer or traveller; but the ranchman finds in the deep grassy valleys of the "Lands" a winter shelter for his cattle.

It is from the petrified forests of the "Bad Lands" that the geologist has disinterred the skeletons of hundreds of different genera of animals which in bygone ages lived in the almost tropical forests which at that time clothed the country.

The fantastic shape of the land is made more remarkable by the wonderful colours on the surface of the hills.

Many coal seams have been ignited by prairie fires, some of which are still burning, emitting smoke and sulphurous fumes. The reddish slag which forms the earth's surface above these fires resembles lava; but the region was never the centre of volcanic disturbances.

The Great Basin

(iv.) The Cordillera Region consists of a succession of great plateaux rising into lofty mountains and named from the principal rivers draining them, such as the Yukon, Fraser, Columbia, Colorado, etc. Within this region also is the inland drainage basin known as the Great Basin draining into the Great Salt Lake of Utah, etc. The mountains in various parts rise to heights exceeding in some cases 20,000 feet and containing many volcanoes. C. J. S.

Photo: by permission of the High Commissioner for Canada.

BUFFALOES IN THE PARK AT WAINWRIGHT, ALBERTA.

Continued from page 236.

MATHEMATICS:

Contributor: —ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A.[Lond.]).

ARITHMETIC.—XXI

145. SCALES OF NOTATION.

We have hitherto expressed all numbers by the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, on the principle that every figure placed to the left of another represents ten times as many as it would do, if it stood in the place of that other.

This is called the common scale of notation, and **ten** is its **base** or **radix.** Any other number, however, may be used as the base of a scale of notation, and sometimes it is convenient to use another scale.

For instance if 3426 were written in the scale of 8, then this number would stand for $3 \times 8^3 + 4 \times 8^2 + 2 \times 8 + 6$.

146. The following examples will show how to express a number written in the common scale of notation in any other scale.

Examples:—

(1) Express 921 in the scale of 6.

Let us consider any number written in the scale of 6, say 4521

$4521 = 1 + 2 \times 6 + 5 \times 6^2 + 4 \times 6^3$.

If we divide this by 6 the first remainder will be 1 which is the first figure on the right of our given number. We then have left $2 + 5 \times 6 + 4 \times 6^2$.

Dividing this by 6, the remainder will be 2 which is the second figure, proceeding from right to left of our given number, and we have left $5 + 4 \times 6$.

We continue this process until we come to a number less than 6 which will be the last figure, proceeding from right to left of our given number. Hence we proceed as follows:

6)921
6)153 — remainder 3
6)25 — remainder 3
4 — remainder 1

∴ 921 expressed in the scale of 6 is **4133.**

(2) Express 87599 in the scale of 12.

Since 12 is greater than 10, we shall have to have two symbols to represent 10 and 11. Let t = 10 and e = 11.

12)87599
12)7299 — remainder e
12)608 — remainder 3
12)50 — remainder 8
4 — remainder 2

Hence 87599 in the scale of 12 is **4283e.**

(3) Find the number in the ordinary scale, which expressed in the scale of 8 is 14724.

$14724 = 1 \times 8^4 + 4 \times 8^3 + 7 \times 8^2 + 2 \times 8 + 4$
$= 4096 + 2048 + 448 + 16 + 4$
$=$ **6612.**

(4) Change 3561 from the scale of 7 to the scale of 8.

We may change 3561 from the scale of 7 to the ordinary scale, and then change this to the scale of 8.

But this result may be obtained by one process thus:

8)3561
8)323 — rem. 5
8)26 — rem. 4
2 — rem. 4

Hence the result is **2445.**

Divide 3 sevens plus 5 by 8, giving the quotient 3 and the remainder 2; next divide 2 sevens plus 6 by 8, giving the quotient 2 and the remainder 4; then divide 4 sevens plus 1 by eight, giving the quotient 3 and the remainder 5; and so on for each line.

147. The scales of two, three, four, ... ten, eleven, twelve are called the Binary, Ternary, Quaternary, Quinary, Senary, Septenary, Octenary, Nonary, Denary, or Decimal, Undenary and Duodenary or Duodecimal Scales respectively.

148. Radix Fractions in any scale correspond to decimal fractions in the ordinary scale.

Thus ·3106 in the scale of 7 stands for $\frac{3}{7} + \frac{1}{7^2} + \frac{6}{7^4}$

Examples:—

(1) Express the fraction $\frac{13}{108}$ by a series of radix fractions in the scale of 6. Consider ·453 written in the scale of 6. This stands for $\frac{4}{6} + \frac{5}{6^2} + \frac{3}{6^3}$.

If we multiply by 6 the integral part of the product will be 4, the first figure after the point, and the fractional part will be $\frac{5}{6} + \frac{3}{6^2}$.

If we again multiply by 6, the integral part of the product will be 5, which is the second figure after the point.

Thus the figures can be found in order by multiplying the given fraction by 6 and the fractional part of the product again by 6 and so on.

$\frac{13}{108} \times 6 = 0 + \frac{13}{18}$; $\frac{13}{18} \times 6 = 4 + \frac{1}{3}$; and $\frac{1}{3} \times 6 = 2$.

Hence $\frac{13}{108} = \frac{0}{6} + \frac{4}{6^2} + \frac{2}{6^3} =$ **·042** expressed by radix fractions in the scale of 6.

(2) Change 719·24 from the scale of 12 to the scale of 7.

```
7 )719                  24
  7 )103 — 0             7
    7 )19 — 0          1·44
        3 — 0             7
                       2·64
                          7
                       3·84
                          7
                       4·t4
                          7
                       6·04
                          7
                       0·24
```

Hence the result is **3000·$\dot{1}$2346$\dot{0}$.**

149. The duodecimal scale of notation is specially useful in finding areas and volumes expressed in terms of feet and inches. We consider the foot a unit, then the inch is one-twelfth, and clearly units multiplied by twelfths give twelfths, i.e. $5 \times \frac{1}{12} = \frac{5}{12}$

and twelfths multiplied by units also give twelfths, i.e. $\frac{5}{12} \times 2 = \frac{10}{12}$.

Again twelfths multiplied by twelfths give hundred-and-forty-fourths, i.e. $\frac{5}{12} \times \frac{7}{12} = \frac{35}{144}$.

Twelfths are called **primes,** hundred-and-forty-fourths are called **seconds,** and so on to thirds, fourths, etc.

3 ft. 7 primes 2 seconds are written 3ft. 7′ 2″.

Examples :—

(1) Find the area of a piece of wood 5 ft. 9 in. by 3 ft. 7 in.

```
ft.
5 — 9′
3 — 7′
————————
17 — 3′
3 — 4′ — 3″
————————
20 — 7′ — 3″
```

We commence by multiplying the primes in the first line by the feet in the second line. Thus 3 × 9′ = 27 primes = 2 ft. 3 primes; write down the primes and carry 2. Then 3 × 5 = 15, 15 + 2 = 17 and so on.

The result is 20 sq. ft. 7 primes 3 seconds = **20 sq. ft., 87 sq. in.**

(2) Find the volume of a solid whose measurements are 3 ft. 6 in. by 2 ft. 9 in. by 3 ft. 6 in.

```
ft.
3 — 6′
2 — 9′
————————
7 — 0′
2 — 7′ — 6″
————————
9 — 7′ — 6″
3 — 6′
————————
28 — 10′ — 6″
4 — 11′ — 9″ — 0‴
————————
33 — 10′ — 3″
————————
```

The result is 33 cub. ft. 10 primes 3 seconds = **33 cub. ft., 1476 cub. in.**

150. In conclusion we will give examples of how to solve certain typical problems.

(1) A recipe directs the mixture of a cub. cm. of a substance A, and b cub. cm. of a substance B, but by mistake a grammes and b grammes respectively are taken. Find the proportions of A and B in the mixture estimated by volume, it being given that p cub. cm. of A weigh x grammes, and q cub. cm. of B weigh y grammes. (*London Matriculation Examination.*)

x grammes of A have a vol p cub. cm.

∴ a „ „ „ $\frac{ap}{x}$ cub. cm.

y „ B „ q cub. cm.

∴ b „ „ „ $\frac{bq}{y}$ cub. cm.

∴ estimated by vol. the proportions of A to B are $\frac{\frac{ap}{x}}{\frac{bq}{y}} = \frac{apy}{bqx}$

Answer **apy : bqx.**

(2) Water flows into a cistern from a tap A and flows out through a tap B. When both A and B are open the cistern is filled in p minutes, and when only B is open the cistern is emptied in q minutes. In how many minutes can the cistern be filled when B is closed? (*London Matriculation Examination.*)

B empties cistern in q minutes

∴ in 1 minute B empties $\frac{1}{q}$ of cistern

∴ in p minutes „ „ $\frac{p}{q}$ „ „

∴ in p „ A fills $\left(1 + \frac{p}{q}\right)$ of cistern

$= \frac{p+q}{q}$ of cistern.

Since A fills $\frac{p+q}{q}$ of cistern in p minutes

∴ A fills whole of cistern in $\frac{p}{\frac{p+q}{q}}$ minutes

$= \frac{pq}{p+q}$ **minutes.** Answer.

(3) A manufacturer makes an article at the cost of £a and sells it to a wholesale dealer; the dealer sells it to a shopkeeper at a profit of p per cent., and the shopkeeper sells it to a customer for £b, making a profit of q per cent.

Find the manufacturer's profit per cent., and also find in what ratio the price paid by the customer is increased if the manufacturer doubles his profit, the dealer and shopkeeper taking the same percentage as before. (*London Matriculation Examination.*)

Price paid by shopkeeper $= \frac{100}{100+q}$ of £b.

Price paid by dealer $= \frac{100}{100+p}$ of price paid by shopkeeper

$= \frac{100^2}{(100+p)(100+q)}$ of £b

Profit of manufacturer on £a

$= \frac{100^2}{(100+p)(100+q)}$ of £b − £a.

∴ Profit of manufacturer on £100

$= \frac{£100}{a}\left[\frac{100^2}{(100+p)(100+q)} \text{ of } £b - £a\right]$

$= £\left[\frac{100^3}{(100+p)(100+q)}\frac{b}{a} - 100\right]$

i.e. profit per cent.

$$= \frac{100^3}{(100+p)(100+q)}\frac{b}{a} - 100.$$

If the manufacturer doubles his profit he gets

$2\left[\frac{100^2}{(100+p)(100+q)} \text{ of } £b - £a\right]$ profit.

∴ dealer pays

$2\left[\frac{100^2}{(100+p)(100+q)} \text{ of } £b - £a\right] + £a$

$= \frac{2\times 100^2}{(100+p)(100+q)}$ £b − £a

∴ shopkeeper pays $\frac{100+q}{100}$ of what dealer pays

$= \frac{2+100}{(100+p)}$ £b − £ $\frac{a\times(100+q)}{100}$

∴ customer pays $\frac{(100+p)}{100}$ of what shopkeeper pays

$= £2b - \frac{£a\,(100+q)\,(100+p)}{100^2}$

∴ price for customer is increased in ratio of

$£b : £2b - \frac{£a\,(100+p)\,(100+q)}{100^2}$

i.e. in ratio of

$$1 : 2 - \frac{a}{b}\frac{(100+p)\,(100+q)}{100^2}.$$

(4) A stream flows from A to B four miles distant, at the rate of $2\frac{1}{4}$ miles per hour. Two men, who each can row at the rate of 6 miles per hour in still water, start simultaneously from A and B to row towards each other; when they meet, each at once turns and rows back to his starting point, and then again turns and rows to meet the other. Find the distance between the two meeting points and the interval which elapses between the two meetings. (*London Matriculation Examination.*)

A — y — x — B

If P starts from A, he rows towards B at $8\frac{1}{4}$ miles/hr.

If Q starts from B, he rows towards A at $3\frac{3}{4}$ miles/hr.

∴ P and Q approach at rate of $8\frac{1}{4} + 3\frac{3}{4} = 12$ miles/hr.

∴ between them they cover 4 miles in $\frac{1}{12}$ of $4 = \frac{1}{3}$ hr.

In $\frac{1}{3}$ hr. P has rowed $\frac{1}{3}$ of $8\frac{1}{4} = \frac{11}{4}$ miles, i.e. x is $\frac{11}{4}$ miles from A.

From x to B, Q has to row $\frac{5}{4}$ miles at $8\frac{1}{4}$ miles/hr.

∴ Q reaches B in $\frac{5}{4}\times\frac{4}{33} = \frac{5}{33}$ hr.

From x to A, P has to row $\frac{11}{4}$ miles at $3\frac{3}{4}$ miles/hr.

∴ P reaches A in $\frac{11}{4}\times\frac{4}{15} = \frac{11}{15}$ hr.

Since Q turns when he reaches B, he rows up stream for $(\frac{11}{15} - \frac{5}{33})$ hr. $= \frac{32}{55}$ hr. by the time P reaches A.

In $\frac{32}{55}$ hr. Q rows $\frac{32}{55}\times\frac{15}{4} = \frac{24}{11}$ miles

∴ P and Q begin to approach each other again when they are $4 - \frac{24}{11} = \frac{20}{11}$ miles apart.

∴ P and Q meet in $\frac{20}{11}\times\frac{1}{12} = \frac{5}{33}$ hrs. after P turns.

In $\frac{5}{33}$ hrs. P goes $\frac{5}{33}\times\frac{33}{4} = \frac{5}{4}$ miles

∴ they meet at y which is $\frac{5}{4}$ miles from A

∴ distance between x and y $= \frac{11}{4} - \frac{5}{4}$

$$= 1\tfrac{1}{2} \text{ miles.}$$

Interval of time which P takes to row from x to A and back to y $= (\frac{11}{15} + \frac{5}{33})$ hrs. $=$ **53′ 5½″.**

Exercise 50

(1) Express 359 in the scale of 3.

(2) Express 12345 in the scale of 12.

(3) Transform 15768 from the scale of 9 to the ordinary scale.

(4) Transform 478e6 from the scale of 12 to the ordinary scale.

(5) Find by duodecimals:

(*a*) the area of a piece of wood 3 ft. 7 in. by 2 ft. 9 in.

(*b*) the volume of a box 3 ft. 6 in. by 2 ft. 9 in. by 2 ft. 7 in.

Key to Exercise 48

(1) 13. (2) 49. (3) 101. (4) 320·2. (5) 72·21. (6) 1·46. (7) ·53.

Key to Exercise 49

(1) $2\sqrt{3} + 2\sqrt{5}$. (2) $3\sqrt{2} + \sqrt{21}$. (3) $3\sqrt{2} + 2\sqrt{3} + \sqrt{10} + \sqrt{15}$. (4) 2. (5) 1. (6) $35 - 14\sqrt{6}$. (7) $\frac{3 - \sqrt{2} - \sqrt{3} + \sqrt{6}}{2}$. (8) $\frac{24 + \sqrt{6}}{30}$.

(9) $(2 - \sqrt{2})\frac{1 + \sqrt{3}}{2}$. (10) $\sqrt{6} + \sqrt{3} - 2\sqrt{2} - 1$.

(11) ·05081. (12) ·31331.

Key to Exercise 50

(1) 111022. (2) 7189. (3) 10835. (4) 96330. (5) (*a*) 9 sq. ft. 123 sq. in. (*b*) 24 cub. ft. 1494 cub. in.

M. A. L.

ALGEBRA.—XX

122. Imaginary and Complex Quantities. —CONSIDER the equation $x^2 + 1 = 0$. Its solution is $x^2 = -1$ $\therefore x =$ no real quantity $\because$ the square of every real quantity is positive.

We now introduce a new symbol i which satisfies the above equation.

We define i as such that $i \times i = -1$.

Further, we assume that i satisfies the associative and commutative laws, so that

$$ai = ia, \text{ and } a + bi = bi + a.$$

ai is called an **imaginary number,** a being real. $a + bi$, where a and b are real, is called a **complex number.** $0 \times i$ is assumed $= 0$.

If $a + bi$ vanish, then a and b must each vanish, otherwise the real number a would $=$ imaginary number $-bi$
and we should have $a = -bi$
$\therefore a^2 = (-bi)(-bi) = (bi)(bi) = bibi = b^2ii = b^2(-1) = -b^2$
which is impossible.

If $a + bi = c + di$, then $a = c$ and $b = d$
for $(a - c) = (d - b)i$
$\therefore a - c$ must $= 0$ i.e. $a = c$, and $d - b$ must $= 0$ i.e. $d = b$.

$a + bi$ and $a - bi$ are called **conjugate complex numbers.** Their sum $= 2a$ is real, and their product $= a^2 + b^2$ is real.

Conversely, if $a + bi$ and $c + di$ are two complex numbers such that their sum and their product are both real, then they must be conjugate.

For $a + bi + c + di = (a + c) + (b + d)i$ and if this is real $b + d = 0$ $\therefore d = -b$.

Hence the numbers are $(a + bi)$ and $(c - bi)$; $(a + bi)(c - bi) = ac + bi(c - a) + b^2$, and if this is real, $b(c - a)$ must $= 0$ $\therefore$ either $b = 0$ or $a = c$.

If $b = 0$ both numbers are real, which is contrary to hypothesis.

If $c = a$ then the numbers are $a + bi$ and $a - bi$, i.e. they are conjugate.

The product of the conjugate complex numbers $a + bi$ and $a - bi$ is $a^2 + b^2$ which is real.

The positive value of $\sqrt{a^2 + b^2}$ is called the **modulus** of either of the complex numbers.

If a complex number vanishes, its modulus vanishes. The converse is also true.

The modulus of the product of two complex numbers is equal to the product of their moduli.

$$\text{mod. } (a + bi) = +\sqrt{a^2 + b^2}$$
$$\text{mod. } (c + di) = +\sqrt{c^2 + d^2}$$
$$(a + bi)(c + di) = (ac - bd) + (ad + bc)i$$
$$\text{mod. } \{(ac - bd) + (ad + bc)i\} = +\sqrt{(ac - bd)^2 + (ad + bc)c^2} = +\sqrt{(a^2 + b^2)(c^2 + d^2)}$$

Hence $\text{mod. } [(a + bi)(c + di)] = \{\text{mod. } (a + bi)\}\{\text{mod. } (c + di)\}$

This holds for any number of factors.

From this we deduce that **the modulus of a quotient equals the modulus of the dividend ÷ modulus of divisor.**

Consider the quotient $\dfrac{a + bi}{c + di}$

$$\frac{a + bi}{c + di} = \frac{a + bi}{c + di} \times \frac{c - di}{c - di} = \frac{(ac + bd) + (bc - ad)i}{c^2 + d^2} = \frac{ac + bd}{c^2 + d^2} + \frac{bc - ad}{c^2 + d^2}i$$

$$\therefore \text{mod. } \left(\frac{a + bi}{c + di}\right) = +\sqrt{\left(\frac{ac + bd}{c^2 + d^2}\right)^2 + \left(\frac{bc - aa}{c^2 + d^2}\right)^2} = +\sqrt{\frac{(a^2 + b^2)(c^2 + d^2)}{(c^2 + d^2)^2}} = +\sqrt{\frac{a^2 + b^2}{c^2 + d^2}} = \frac{\text{mod. } (a + bi)}{\text{mod. } (c + di)}$$

$\sqrt{a + bi}$ can always be expressed as a complex number.

If $\sqrt{a + bi} = x + yi$ where x and y are real then $a + bi = x^2 - y^2 + 2xyi$
$\therefore a = x^2 - y^2$ (i) and $b = 2xy$ (ii)
$\therefore x^4 - 2x^2y^2 + y^4 = a^2$
$4x^2y^2 = b^2$
$\therefore (x^2 + y^2)^2 = a^2 + b^2$
$\therefore x^2 + y^2 = +\sqrt{a^2 + b^2}$ (iii)

We exclude the negative root $\because x$ and y are supposed real.

Combining (i) and (iii) we get

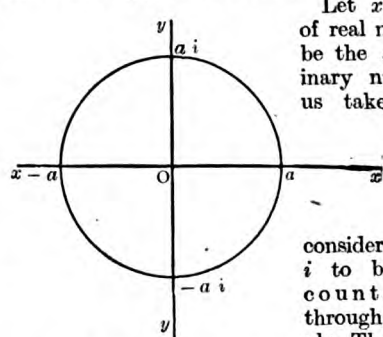
$$x^2 = \tfrac{1}{2}(+\sqrt{a^2 + b^2} + a)$$
$$y^2 = \tfrac{1}{2}(+\sqrt{a^2 + b^2} - a)$$

These give two values for x and two values for y, and we must choose these so that the equation (ii) is satisfied.

If b is positive, then if we take x positive, we must take y positive, and if we take x negative, we must take y negative.

Thus we get two values of $x + yi$, with the signs reversed.

We may represent i as a symbol of operation in the following geometric manner.



Let x be the axis of real numbers and y be the axis of imaginary numbers. Let us take a units of length in the positive direction of the x axis, and let us consider the operation i to be a rotation counter-clockwise through one right angle. Then if we rotate the line containing a units through one right angle, its extremity will be at the point marked ai in the figure. If we operate again with i we shall turn through another right angle, and its extremity will reach the position marked $-a$, where the a units are measured in the opposite direction to that from which we started. Hence we see

$$i.i.a = (-1) \times a$$
$$\therefore i^2 = -1 \therefore i = \sqrt{-1}$$

If we again operate twice in succession with i,

the extremity of the line will again reach the starting point a. Thus we see that as a symbol of operation i may be interpreted as a rotation counter-clockwise through one right angle.

Examples :—

(1) Reduce $(6 - 8i)(3 + 5i)$ to the form $x + yi$ where x and y are real.

$(6 - 8i)(3 + 5i) = 18 + 6i + 40 = 58 + 6i$

(2) Show that $\sqrt{i} = \pm \frac{1+i}{\sqrt{2}}$

This amounts to proving that $\left(\pm \frac{1+i}{\sqrt{2}}\right)^2 = i$

$\left(\pm \frac{1+i}{\sqrt{2}}\right)^2 = \frac{1}{2}(1 + 2i - 1) = i.$

(3) Construct an integral equation whose roots are $3 + i$ and $3 - i$

If the equation be of the form

$x^2 - (\alpha + \beta)x + \alpha\beta = 0$

where α and β are its roots, then

$-(\alpha + \beta) = -(3 + i + 3 - i) = -6$

and $\alpha\beta = (3 + i)(3 - i) = 10$

$\therefore$ the equation is $x^2 - 6x + 10 = 0$

123. Cube Roots of Unity.

On page 300, Vol. II., we found that the three cube roots of unity are

$1, \frac{1}{2}(-1 + \sqrt{-3}), \frac{1}{2}(-1 - \sqrt{-3}).$

The imaginary roots may be written

$\frac{1}{2}(-1 + \sqrt{3}\,i)$ and $\frac{1}{2}(-1 - \sqrt{3}\,i)$.

An imaginary cube root of unity is generally represented by ω; or when we wish to distinguish between them, by ω_1 and ω_2. Thus $1, \omega_1, \omega_2$ are the three roots of the equation $x^3 - 1 = 0$.

Taking the above values, we have

$1 + \omega_1 + \omega_2 = 1 + \frac{1}{2}(-1 + \sqrt{3}\,i) + \frac{1}{2}(-1 - \sqrt{3}\,i) = 0.$

and $\omega_1\,\omega_2 = \frac{1}{4}(-1 + \sqrt{3}\,i)(-1 - \sqrt{3}\,i) = 1.$

Again, $\omega_1^2 = \frac{1}{4}(-1 + \sqrt{3}\,i)^2 = \frac{1}{2}(-1 - \sqrt{3}\,i) = \omega_2$

and $\omega_2^2 = \frac{1}{4}(-1 - \sqrt{3}\,i)^2 = \frac{1}{2}(-1 + \sqrt{3}\,i) = \omega_1$

so that $\omega_1^2 = \omega_2$ and $\omega_2^2 = \omega_1$.

124. Ratio.

Ratio is the relative magnitude of two quantities, the comparison being made with reference to what multiple, part or parts one quantity is of another. **Concrete quantities of different kinds can have no ratio to one another;** for example, we cannot compare in magnitude miles and hours.

The ratio of a to b is written $a : b$, and the quantities a and b are called the **terms** of the ratio: the first quantity is called the **antecedent** and the second is called the **consequent.**

The ratio $a^2 : b^2$ is called the **duplicate** ratio of $a : b$.

The ratio $a^3 : b^3$ is called the **triplicate** ratio of $a : b$; and the ratio $\sqrt{a} : \sqrt{b}$ is called the **subduplicate** ratio of $a : b$.

We find what multiple, part or parts a is of b by dividing a by b.

$\therefore$ the ratio $a : b$ is measured by the fraction $\frac{a}{b}$.

The principal properties of fractions, and therefore of ratios, have already been dealt with on page 106, Vol. II. We repeat the following, which are important.

(1) A ratio is unaltered by multiplying each of its terms by the same number,

$$\left(\text{for } \frac{a}{b} = \frac{ma}{mb}\right).$$

(2) Two or more ratios can be compared by reducing to a common denominator the fractions which express them.

(3) The ratio of two fractions can be expressed as the ratio of two integers,

$$\left(\text{for } \frac{a}{b} : \frac{c}{d} = \frac{\frac{a}{b}}{\frac{c}{d}} = \frac{ad}{bc}\right)$$

When the ratio of two quantities cannot be expressed by the ratio of two integers, they are said to be incommensurable. Thus $\frac{\sqrt{3}}{4}$ is incommensurable, but we may arrive at as close an approximation as we like by working the square root to a sufficient number of decimal places.

A ratio is made more nearly equal to unity by adding the same positive quantity x to each of its terms; and it can be made as nearly equal to unity as we please by making x sufficiently large.

Let the ratio be $a : b$ where a and b are positive quantities.

$$\frac{a}{b} - 1 = \frac{a-b}{b} \text{ and } \frac{a+x}{b+x} - 1 = \frac{a-b}{b+x}$$

Now it is clear that the absolute value of $\frac{a-b}{b}$ is greater than that of $\frac{a-b}{b+x}$, since the numerators are the same, and the denominator $b + x >$ denominator b. Hence $\frac{a+x}{b+x}$ differs from 1 by less than $\frac{a}{b}$, which proves the theorem.

Now when x is very great $\frac{a-b}{b+x}$ is very small and $\therefore \frac{a-b}{b+x}$, which is the difference between $\frac{a+x}{b+x}$ and unity, can be made smaller than any assignable quantity by making x sufficiently large.

This is sometimes expressed by saying that the **limiting value** of $\frac{a+x}{b+x}$ is unity when x is infinitely great.

It follows from the above that a **ratio is removed further from unity by subtracting the same positive quantity from each of its terms.**

125. Proportion.

Four quantities are said to be **proportional** or **in proportion,** when the ratio of the first to the second equals the ratio of the third to the fourth.

Thus a, b, c, d are in proportion if

$a : b = c : d$

or as it is often written, $a : b :: c : d$, which is read "a is to b as c is to d."

a and d are called the **extremes** and b and c are called the **means.**

If $\frac{a}{b} = \frac{c}{d}$, multiply both by bd

then $ad = bc$.

That is, if **four quantities are in proportion, the product of their extremes equals the product of their means.**

Conversely, if $ad = bc$, then a, b, c, d will be in proportion.

For $ad = bc$

then $\frac{ad}{bd} = \frac{bc}{bd} \therefore \frac{a}{b} = \frac{c}{d}$, i.e. $a : b :: c : d$.

Hence also we get the following:

If $a : b :: c : d$, then

$a : c :: b : d$

$b : a :: d : c$

$c : a :: d : b$

Quantities are said to be in **continued proportion** if the ratios of the first to the second, of the second to the third, of the third to the fourth, and so on, are all equal.

Thus a, b, c, d ..... are in continued proportion if $a : b = b : c = c : d = ...$

If $a : b = b : c$ then b is called the **mean proportional** between a and c; and c is called the **third proportional** to a and b.

If $\frac{a}{b} = \frac{b}{c}$, then $b^2 = ac \therefore b = \sqrt{ac}$

Thus **the mean proportional of two quantities is the square root of their product.**

Also if $\frac{a}{b} = \frac{b}{c}$ then $\frac{a}{b} \times \frac{b}{c} = \frac{b}{c} \times \frac{b}{c}$

i.e. $\frac{a}{c} = \frac{b^2}{c^2} = \frac{a^2}{b^2}$

Thus, **if three quantities are in continued proportion, the ratio of the first to the third is the duplicate ratio of the first to the second.**

If $a : b = c : d$ then

$a + b : b = c + d : d$ ..... (i)

$a - b : b = c - d : d$ ..... (ii)

$a + b : a - b = c + d : c - d$ ..... (iii)

$la + mb : pa + qb = lc + md : pc + qd$ ... (iv)

$a^n : b^n = c^n = d^n$ ..... (v)

$la^n + mb^n : pa^n : qb^n = lc^n + md^n : pc^n + qd^n$ (vi)

Where l, m, p, q are any quantities of which l and m do not both vanish and p and q do not both vanish, and where n is a commensurable real number.

The above are all particular cases of (vi). They are all proved by the same method; we shall, therefore, only prove Nos. iii and vi.

Let $\frac{a}{b} = \frac{c}{d} = k$ then $a = bk$, $c = dk$.

$\therefore \frac{a+b}{a-b} = \frac{bk+b}{bk-b} = \frac{k+1}{k-1}$

and $\frac{c+d}{c-d} = \frac{dk+d}{dk-d} = \frac{k+1}{k-1}$

$\therefore \frac{a+b}{a-b} = \frac{c+d}{c-d}$ which proves (iii)

Again $\frac{la^n + mb^n}{pa^n + qb^n} = \frac{l(bk)^n + mb^n}{p(bk)^n + qb^n} = \frac{b^n(lk^n + m)}{b^n(pk^n + q)}$

$= \frac{lk^n + m}{pk^n + q}$

and $\frac{lc^n + md^n}{pc^n + qd^n} = \frac{l(dk)^n + md^n}{p(dk)^n + qd^n} = \frac{lk^n + m}{pk^n + q}$

which proves (vi).

Examples:—

(1) For what value of x will $7 + x : 12 + x$ be equal to 5 : 6. If $\frac{7+x}{12+x} = \frac{5}{6}$, then $42 + 6x = 60 + 5x$

$\therefore x = 18$.

(2) Insert a mean proportional between 4 and 16: mean proportional $= \sqrt{4 \times 16} = \sqrt{64} = 8$

(3) If $a : b :: c : d$ shows that

$a^2 + ab + b^2 : c^2 + cd + d^2 :: a^2 - ab + b^2 : c^2 - cd + d^2$

Let $\frac{a}{b} = \frac{c}{d} = k$ then $a = bk$ and $c = dk$

then $\frac{a^2 + ab + b^2}{a^2 - ab + b^2} = \frac{b^2k^2 + b^2k + b^2}{b^2k^2 - b^2k + b^2} = \frac{k^2 + k + 1}{k^2 - k + 1}$

and $\frac{c^2 + cd + d^2}{c^2 - cd + d^2} = \frac{d^2k^2 + d^2k + d^2}{d^2k^2 - d^2k + d^2} = \frac{k^2 + k + 1}{k^2 - k + 1}$

$\therefore \frac{a^2 + ab + b^2}{a^2 - ab + b^2} = \frac{c^2 + cd + d^2}{c^2 - cd + d^2}$

$\therefore a^2 + ab + b^2 : c^2 + cd + d^2 :: a^2 - ab + b^2 : c^2 - cd + d^2$

Exercise 28

Reduce to the form $x + yi$, where x and y are real.

(1) $(1 + i)^3$. (2) $(1 + \sqrt{3}i)^4 + (1 - \sqrt{-3})^4$

(3) Find the value of $\frac{x^2 - x + 1}{x^2 + x + 1}$, when $x = 2 + 3i$.

(4) Show that $\sqrt{-i} = \pm \frac{(1-i)}{\sqrt{2}}$. 5. Construct an integral equation whose roots are $\sqrt{3} + i$, $\sqrt{3} - i$, $-\sqrt{3} + i$, $-\sqrt{3} - i$.

Exercise 29

(1) Find x in the following:

(a) $2 : 4 :: x : 6$. (b) $x : 2 :: 6 : 4$. (c) $3 : x :: x : 48$.

(2) Find a fourth proportional to

(a) x, xy, z. (b) $a^2, 2ab, 3b^2$. (c) $x^3, xy, 5x^2y$.

(3) Find a third proportional to

(a) a^2b, ab. (b) $3x, 6xy$. (c) $1, a$.

(4) Find a mean proportional between

(a) a^2, b^2. (b) $12ax^2, 3a^3$. (c) $2ax^2, 16a$.

(5) Find x so that $x + 1 : x + 6$ may be the duplicate ratio of 3 : 5.

(6) Three numbers are in continued proportion, the middle one is 12 and the sum of the others is 25. Find the numbers.

(7) If $x - x^1 : y - y^1 :: x + x^1 : y + y^1$, show that $x : x^1 :: y : y^1$.

(8) If $a : b :: c : d$ show that (i) $ab + cd$ is a mean proportional between $a^2 + c^2$ and $b^2 + d^2$. (ii) $a : b :: \sqrt{3a^2 + 5c^2} : \sqrt{3b^2 + 5d^2}$.

Key to Exercise 27

(1) $5 + \sqrt{6}$. (2) $\frac{4}{5}\sqrt{2}$. (3) $\frac{7a + b + 8\sqrt{a^2 - b^2}}{3a + 5b}$.

(4) $\sqrt{3}$. (5) $\frac{1}{10}(\sqrt{6} + \sqrt{10} - \sqrt{21} - \sqrt{35})$.

(6) $\frac{1}{3}(4\sqrt[3]{4} + 2\sqrt[3]{2} + 4)$. (7) $\sqrt{10} + \sqrt{3}$.

(8) $2\sqrt{11} - \sqrt{3}$. (9) $\sqrt{\frac{2}{3}}$. (10) $x - 5y$.

(11) $ax^5 - 2bx^2 + 3c$. (12) $\frac{a^2}{8} + \frac{a}{2} - 1$. (13) $\frac{5x}{y} - 2 - \frac{y}{5x}$. (14) $1 - 2x + 3x^2$. (15) $3x^2 - x + 6$. M. A. L.

Continued from page 241.

ART AND MUSIC:

Contributors :—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O. ; Hubert Grant).

DRAWING.—XIII

THE human figure presents what is, in nine cases out of ten, the subject which most attracts the student of art. The fascination of such work, though without the endless variety of landscape, is paramount. Satisfactorily to accomplish the drawing of the human form does, however, require the utmost care and diligence.

It has been said that those who can draw the figure well can draw anything else. This may be true to a limited extent. But men who have been wonderful portrait painters and admirably accomplished at drawing the human form have been at the same time poor landscape artists.

What is really meant by the above generalisation is that once you have so mastered your pencil as to be able to draw the human figure really well, you will be sufficient master of your pencil to draw pretty nearly anything well. *But the last word in art is spoken not by technical perfection, nor the controlled use of materials, but by inspiration.* Inspiration is the intensest form of individualism as expressed in art.

It was said above that there was less variety about the human figure than about landscape from the artist's point of view. This is true only in a superficial sense. For the human figure includes the face, and the face is capable of every expression, every shade of expression, denoting the infinite degrees of every kind of emotion. Love, pity, sorrow, anger, hatred, fear, defiance—there is no end to them. And it is the artist's business to depict these emotions in their every aspect through the medium of his art. Even in the more superficial sense there is variety enough. Men and women in all positions: beautiful women, ugly men.

Fig. 73.—Explaining the face line and face angle which give an intellectual type purely Greek

Before attempting to draw the human form it is absolutely necessary to have some knowledge of anatomy. Just as in discussing the question of foliage you are warned to make a study of the trees and their branches, their dispositions and characteristics, so here you must understand how the human form comes to be built up as it is, what is immovably the same always, what is subject to variation. Anatomy also teaches you the true proportion of the figure, and how each bone and each muscle is interdependent upon the rest.

First of all we have to consider the skeleton—the scaffolding on which the body is built up. Fig. 74 shows a male skeleton, which should be carefully studied.

A few rough rules are worth learning as to general proportions. A man's total height may be reckoned as equal to seven and a-half or eight heads, the head being reckoned from the crown to the chin. In the case of a child the proportion varies according to age. A child of seven or eight years of age may reckon on the basis of five heads and a-half, a baby nearly four.

Now fully extend your arms, hands, and fingers on either side of you horizontally. You will

then find by measurement that the length from the finger-tips of your right hand to those of your left measure the total length (or height) of your body. Therefore if you are well proportioned, you may stand in a square frame, with head, feet, and the tips of the fingers of either hand touching that frame.

Then as to comparative distances, the length of the upper bone of the arm A to B, the elbow, is equal to the distance from B to C, which is the first knuckle of the hand.

The same applies to the line A D (that is, between the outer part of the shoulders), which is the same distance So is the top of the breast bone, E, to the navel, F: so is the lower part of the breast-bone, G, to the pubis, H. Thence to the top of the knee-cap, I, the same. And from the lower part of that, K, to M, the instep, is once more the same. Naturally it follows that these uniform lengths are of great help when drawing the figure.

It is just as well to remember the Latin names for some of these various parts of the body, as they are frequently used in all literature connected with art. A reference to the letters above is sufficient. A–B, humerus. E, sternum. I, patella.

The next point to discuss is the *Facial Angle*. Upon the facial line and angle depends the difference between the higher types of manhood and the negro and the animal. An authority gives the following instruction for experiment in this direction.

"Draw a line," he says, "from the lower extremity of the ear through the closing of the teeth in front and draw another along the outer projection of the forehead to meet it." This last line is called the Facial Line and the two together form the facial angle (see Fig. 73). This figure gives a very high type of intellectual face, purely Greek.

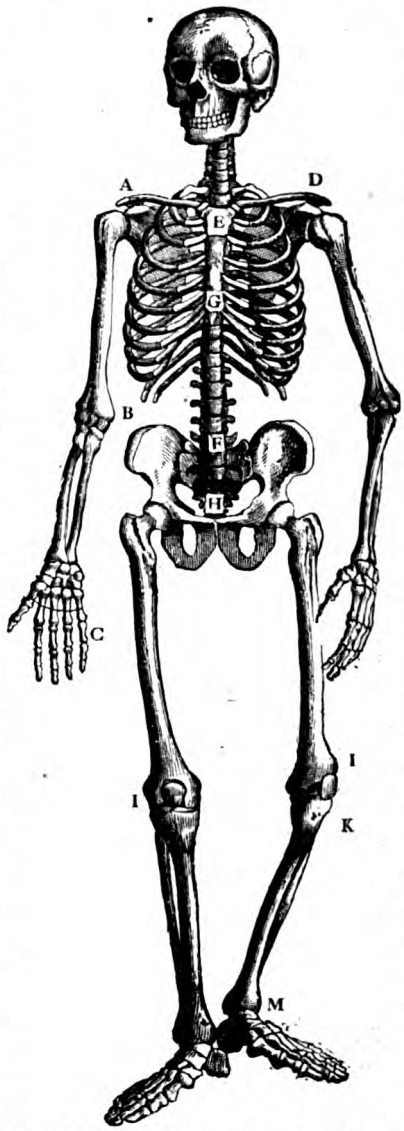


Fig. 74.—THE HUMAN SKELETON: COMPARATIVE MEASUREMENTS.

The distances A to B, B to C, A to D, E to F, G to H, H to I, K to M are all equal.

As the facial angle becomes more acute, it becomes more and more characteristic of the lower animals. About eighty degrees shows the highest power of intellect and generally indicates beauty too. So greatly were the old sculptors of Greece impressed with this doctrine that they generally gave their gods of marble a facial angle of ninety degrees—that is to say, a right angle. They even went beyond this now and again.

If you wish to see the difference in type presented by this one characteristic of the facial angle, you have only to compare that belonging to an intellectual man, a negro, a cow.

By studying this point (it need not be gone into exhaustively) you will be helped in considering the human head from the artistic point of view.

You should realise at once in your study of the human figure that the word "outline" has a far larger significance than elsewhere in drawing. First of all there is the outline in the sense to which you are accustomed; that is to say, the boundary line of the figure in whatever position you happen to be studying it.

But within this boundary-line there is much to be expressed — quite as much as in the boundary-line itself, probably more. Unless you can render these "interior outlines," to use a paradox, you cannot draw the human body. There are uneven and unequal surfaces everywhere, some parts are foreshortened, some parts project, according to the action of the muscles—these require a certain amount of anatomical knowledge. You have only to try to draw the human figure *without* having that knowledge in order to discover how essentially important it is.

Take an instance. Draw a man standing still, his face in profile. This task is comparatively easy. But draw him walking towards you or away from you, and you begin to realise how difficult the subject is. For you must have some knowledge of the play and interplay of the muscles, besides a considerable acquaintance with perspective. But such knowledge is, after all, nothing if it is not accompanied by individual

THE HUMAN FIGURE

Some studies by Byam Shaw. The human figure attracts the art student more strongly than any other class of subject—perhaps because of its difficulty; he who can draw the human figure well can draw almost anything.

perception. As in all kinds of drawing, you must learn by observation. Study men and women you know and see. Watch their movements and their expression of face. Learn to become familiar with not only the commonest and most obvious muscular action, but the least noticeable.

In the far-distant past the Greeks were far ahead of us to-day in the finer points of observation. The turn of a woman's head, momentarily caught, a horse going with only one foot upon the ground—these lightning attitudes which are perfectly true to life were the commonplaces of their art. J. G. B. L.

ART AND COLLECTING

THE faculty of collecting beautiful things is not by any means confined to artists, of course. And yet some knowledge of various forms of art are entirely necessary to the collector, otherwise he will not be proof against fraud.

It is said that the demand creates the supply. Probably it does: and that is why in curio shops you will see an exquisitely beautiful cupboard and chest or cabinet—for this meets a demand. So do the old glass goblets that are arranged on its top. Very well. And so, one supposes, do the hideously ugly china ornaments which are ranged alongside the glass goblets. One I call to mind, having seen it recently in a particularly delectable shop where "rubbish" is scarcely ever to be seen. The ornament in question represented an animal with four legs. It is impossible to go further than that. It may have been a horse, though personally I think it was a dog. More probably it was some mythical beast. It was a bright red in colour and was supported by crude foliage of an almost indecent green.

"How charmingly quaint," said a young woman who was peering into the shop. I believe that the price was really considerable. The thing was old and of some ware which has an almost sacred name. That is enough. Anything of that sort will fetch its price if it is old enough, however ugly.

So here we come to the consideration of the question, do people buy these atrocities because they are old and "quaint," or because they are old and fashionable?—of course there is and has been a great craze for some years past for everything that is old. Now the primary reason for wishing to possess "old" things is because their workmanship is often (but not always) better than modern workmanship, or else because some things are not and cannot be made to-day, or again because of old association. This is perhaps the strongest, if not the most relevant appeal. And it is extremely praiseworthy. But quaintness!

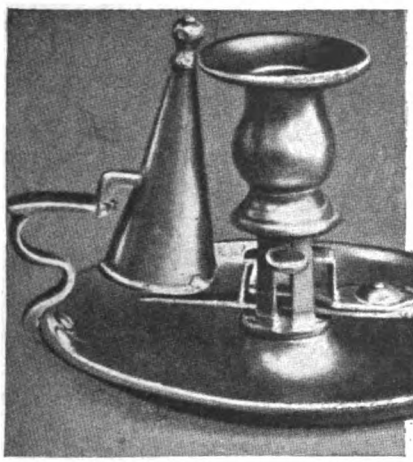
What in heaven's name constitutes quaintness? The dreadful quadruped above described was certainly quaint in the sense that it was uncommonly bad. Not only was the modelling vile and the colour detestable, but the thing was made in a slipshod way. Nobody, however ignorant or even mad, could for a moment believe honestly that it was pleasing to the eye. The thing was monstrous. What associations had it? It may (though never was there a more unlikely hypothesis) have belonged to George III. Very well then, let it be placed in a museum of relics of George III to the poor man's everlasting disgrace.

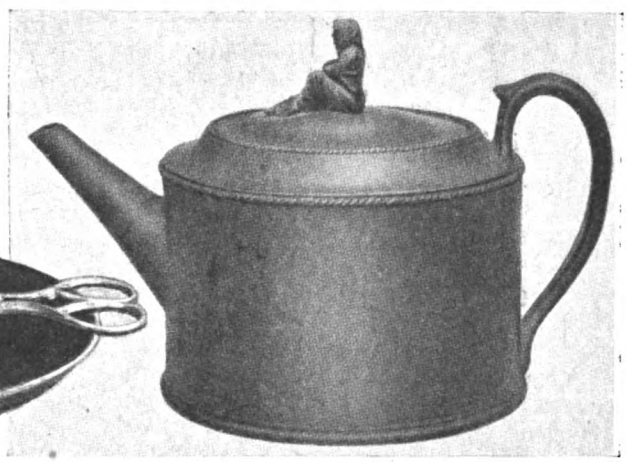
But to desire the thing for the adornment of one's own mantelpiece is beyond the plumbing of the normal mind. That is one aspect of collecting. A pleasanter consideration is the ardent hunt for something—it may be a pewter jug or it may be a Japanese print or an atom of exquisitely-carved jade—for something which the artist's special knowledge tells him is worth having for its own intrinsic sake. Its monetary value is quite beside the point. The true artist does not buy to sell again.

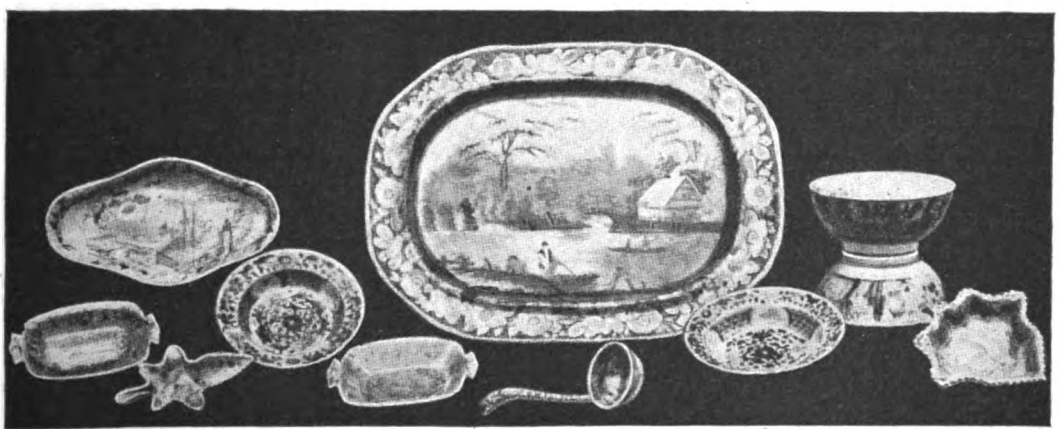
Wayward Delights

Being human he will be happy if the bargain is a good one; but intermediary problems weigh with him very little. He goes straight for the desired object, gets it, and cherishes it as an abiding joy. He even lumbers up his house with things procured in this way until necessary furniture is crowded out or crowded over and the sum total of good effect is spoiled. Then he has to sell or give away. If you are a collector there is no room to be practical.

Practical people are quite necessary to the scheme of things, but they cannot understand the wayward delights of owning unnecessary trifles which entail arduous labour in the finding. The true artist will scrape and scratch and save and go without meals and pawn his clothes—all in the good cause of acquiring something which feasts the eye or clothes his mind with happiness. He argues that the missing dinner can be made up in more prosperous times, but he may never again get such an opportunity of procuring that lovely little Greek vase or early French bronze. J. G. B. L.







Reproduced from "Byways of Collecting," by Ethel Deane.

FOR COLLECTORS.

1. A group of blue and white Worcester (circ. 1750: marked with a *W*); 2. Old Sheffield candlestick with snuffers and extinguisher; 3. Black basalt teapot (marked *Wedgwood*, impressed); 4. Another blue and white group: "Adams" dish (centre); Wedgwood dish (left); Nankin round ice plates; Oriental bowls (right); "Rogers" oblong hors-d'œuvres dishes; Longton Hall ivy leaf dishes; Spode ladle.

Continued from page 248.

BUSINESS AND COMMERCE

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—XIX

RIGHT through the ages there have been inventors; men who by their ingenuity and creative ability have carried forward our knowledge of mechanics and added to the productive wealth of the country. And yet there is always a demand for new inventions; and the evolution that goes on unceasingly though almost imperceptibly is due entirely to those who can create new developments.

To some extent, it may be said that the inventor is a gambler. Perhaps seen in a flash, possibly the patient work of years, the child of his brain is brought to maturity, and from the completion of the model or the preparing of the specifications the future is bounded by many cares and trials.

Marketing an Invention

In the first place, it is only natural that the inventor himself should express undue optimism as to the future of his invention, and he must be prepared for pessimistic shadows to fall across it. Then, lest a thief or pirate should seize upon his invention and rob him of the fruits of his labour, he must keep it secret or patent it. In some cases the inventor will be financially unable to float his idea upon the market, and there are dangers to be anticipated even when seeking a capitalist. In fact, it may truthfully be said that an inventor experiences more difficulties and anxieties in marketing his invention profitably than in the conceiving of it, though the following instructions should go far towards removing these difficulties.

Firstly, let us broadly explain the law of patents. The term "patent" is really the familiarised contraction of "letters patent," the official document which gives to an individual or individuals the sole right to manufacture for sale the particular article specified, for a given number of years. The object of granting a patent is not so much to benefit the actual inventor but rather to give official encouragement to national and commercial development along the lines of the invention.

By law, the inventor enjoys the sole right to make and exploit his invention for a period of fourteen years from the day of its first registration, subject to the payment of fees from year to year. These fees include an initial £4, a sealing fee of £1 and, for renewals after the first four years, an increasing fee on this scale:

	£
For renewals for the 5th year ..	5
" " 6th " ..	6
" " 7th " ..	7
" " 8th " ..	8
" " 9th " ..	9
" " 10th " ..	10
" " 11th " ..	11
" " 12th " ..	12
" " 13th " ..	13
" " 14th " ..	14

Cost of Patenting

It will be seen, therefore, that the cost to patent an invention and to retain the full rights of it for the entire period allowed by law, viz. fourteen years, is £100 sterling. At the same time, the extension beyond the first four years depends entirely upon the renewal fees being paid, and it may be pointed out that whereas certain valuable inventions may with great profit be allowed to remain the right of the inventor for the full period upon paying the fees, there must inevitably be lesser inventions from which the inventors may derive equally full profit during the course of the first four years, at a cost of only £5, viz. £4 for the initial charges and £1 as the sealing fee. Thus, indirectly, the law graduates the payments to be paid according to the actual worth of the invention as may be proved by that least infallible of judges—time.

A further point in favour of the inventor lies in the fact that he may obtain a provisional patent for the period of six months, or for seven months in exceptional circumstances and by paying an additional fee of £2. The main object of this provisional period of six months is to enable the inventor still further to perfect and complete his invention without the risk of someone else working along his lines, either unwittingly or by deliberate design. The fees to be paid for provisional patents amount to £1, with an additional £3 at the end of six months—precisely the same as though a full patent were applied for direct, in both cases the sealing fee of £1 being an extra.

Setting this matter in even clearer form, an inventor may for the payment of only £1 protect his invention for the period of six months, knowing all the time that he will enjoy government backing should his rights be in any way infringed. If at the end of that six months he has proved conclusively that his invention is worthy of the process, he may, by paying a further £3 and the sealing fee of £1, obtain the full patent rights for at least four years.

Furnishing Specifications

And it is in no way specified that patent rights shall be held only by the inventor. They may be granted to two or more individuals, and it frequently occurs that for the due protection of the capitalist the patent stands both in his name and in that of the inventor for their mutual benefit. This applies equally to the granting of provisional rights, and when applying for a provisional patent it is not necessary fully to specify the invention. In fact, so long as the idea is so described that its construction, purpose and intention may be made perfectly clear the furnishing of the complete specification may be delayed until the full patent is sought.

It is not necessary to deposit a model when seeking a patent, though in certain cases of compositions and made-up substances, such as combinations of chemicals, samples are sometimes required. At the same time; it may be imperative for models to be produced for the inspection of financiers —after provisional protection has been obtained.

However, in order clearly to set out the entire routine of patenting and marketing an invention we will assume that some labour-saving device, some piece of machinery, some useful novelty or a profitable invention of some kind has been planned and perfected by an inventor. He wishes primarily to ensure that his rights to his handiwork and its development are protected and secondly he is desirous of profiting by it.

In the vast majority of cases, the inventor will lay the matter before a patent agent. Patent agents act on behalf of the inventor in many directions, and are usually paid for their services by a system of percentage on results, though most of them require a preliminary fee before undertaking a commission. There are patent agents in most towns, but it will be quite obvious that some form of introduction or recommendation should be sought by the inventor before placing his business before a firm that is unknown to him. At the same time, it should be made quite clear that patent agents are registered and no one may advertise that he is an agent without being registered, under a heavy penalty.

Patent Agents

The patent agent, thoroughly versed in every aspect of the subject, will pass an opinion as to the merits of an invention submitted to him, and if it meets with his approval will first of all prepare the preliminary specifications and apply for a provisional patent. It is, of course, not strictly necessary for an inventor to work through a patent agent, but it should be pointed out that the agent stands to the inventor in the relationship of solicitor to client, and there are many matters of form, custom and routine with which the agent will be perfectly familiar but which will be quite beyond the province of the inventor, and one of these matters is certainly the drawing-up of specifications, be they preliminary or final.

And here it may be mentioned that the original application must be made upon a prescribed form, to be obtained from the Patent Office, London, or from the principal Money Order Post Offices throughout the Kingdom, and this form must be lodged at the Patent Office or sent there through the post in the ordinary way.

Having obtained this provisional protection, the inventor may, if it be necessary or desirable, set about still further perfecting his idea; perhaps acting upon suggestions made by the patent agent. And the agent, should it be required, will take steps to introduce a financier who will supply the money needed to float the invention in a commercial sense.

During this provisional period the article

may be made public with perfect security; and may indeed be manufactured and exploited. But before the lapse of the six months (or seven months by the payment of the additional fee) the complete specification must be lodged, and the additional sum of £3 be paid.

Or, as an alternative, the agent or inventor may lodge the complete specifications at once; pay the full sum of £4, and forgo provisional rights altogether. A. B.

CHOOSING A CAREER.—XXI

Holy Orders. — It goes without saying that no young man should seek to be received into the Ministry without a deep consciousness that he is thoroughly fitted to become a religious leader. Service in the churches is in its broadest sense both a career and a profession; but the candidate needs something more than mere academical attainments.

The Church of England.—In the great majority of cases clergymen of the Established Church pass through the Universities of Oxford, Cambridge or Durham. A University training offers such a wide field for the development of culture and learning that it is undoubtedly the course for the candidate for Holy Orders to take.

Generally at the age of nineteen the young man will proceed direct from school to the University, and neither at Oxford nor Cambridge can he take his degree of B.A. until he has been in residence for three years. This means three terms of eight weeks each a year or nine terms in all; and at both the Universities it is not uncommon for those who would take honours to remain for four years.

Thus, entering the University at nineteen and remaining four years, the candidate finds himself twenty-three, which is the minimum age at which a deacon may be ordained. At the same time it may be explained that this final year is frequently spent at a Theological College or Hall at the University, or it may even be spent at a training college elsewhere.

As for the cost of residence at either Oxford or Cambridge, it may be said to range from £200 to £500 a year; but, just as there are many opportunities for spending money, so is there encouragement to be economical, and much must depend upon the tastes of the student.

The usual course taken by a young man before going up to Oxford or Cambridge is to specialise in some subject in which his ability is most marked. Thus equipped, he may win a scholarship or exhibition if he gains a high place at competitive examinations held annually by each, or groups, of the colleges. Scholarships range in value from about £40 or £50 to £100 or more per annum for three or four years. Full information can be obtained on application to any of the colleges.

To gain entrance to the older universities a preliminary examination must be passed, known as the "Previous" at Cambridge and "Responsions" at Oxford; though this test is waived in cases where the student has passed certain prescribed examinations, e.g. the London Matriculation, or the Oxford and Cambridge Senior Local Examinations. For the Previous at Cambridge, Greek is no longer a compulsory subject; and this has proved a great relief to students specialising in the sciences or mathematics.

It must not be imagined, however, that residence at one of the ancient universities provides for what may be termed professional tuition or instruction. The university education is merely such as would fit a young man mentally, socially and morally to become a minister of the Church of England; and this is a point taken into consideration by our bishops in selecting candidates for ordination.

Having, however, obtained a pass or honours degree at the university, it remains for the graduate to attend for special theological training at one of the colleges conducted for that purpose at fees for the year of approximately £100.

Durham University enjoys with Oxford and Cambridge the right to confer Divinity degrees; but both the B.D. (Bachelor of Divinity) and D.D. (Doctor of Divinity) are only to be obtained after a lapse of given years from the date when the M.A. degree was taken, and also from admission to the priesthood.

The modern universities may also be attended by students desirous of becoming clergymen; but in these days quite a number of men obtain ordination without having attended a university at all. In their cases there are Theological Training Colleges, and it may almost be said that there is a college for every diocese; so that where a young man wishes to be ordained, but cannot through circumstances attend at a University, he should write to the Bishop of his Diocese for guidance as to the selection of a college.

To mention a few of the theological

colleges, the following list is given : Cuddesdon College, Oxford ; Ridley Hall and the Clergy Training School, Cambridge ; St. Aidan's College, Birkenhead ; St. David's College, Lampeter ; Ripon College, Ripon ; Cathedral School of Divinity, Truro ; London College of Divinity, Highbury, etc.

Let us assume now that the prospective candidate has obtained his degree, or has prepared himself at a theological college, and that he has reached the age of twenty-three. His next step is to approach the Bishop of his Diocese ; and if he has not already passed a University examination for Candidates for Orders, he must pass the Bishop's examination for Deacon's orders.

He must then produce his certificate of baptism and also testimonials ; and the Bishop will take steps to ascertain that he is in every sense fitted to be ordained. An actual nomination to a curacy is also required, and it may be mentioned that copies of papers set at recent examinations are obtainable from *Messrs. Parker & Co., of Oxford*, or from *Messrs. Deighton, Bell & Co., of Cambridge*.

Following upon his ordination as a deacon the candidate will occupy that status for at least a year ; and at the end of that time may qualify for the priesthood by passing the Priest's Examination, particulars of which are obtainable through the Bishop.

Chaplaincies. — Many of our younger clergymen commence their careers as curates and then after a short period of probationership qualify for chaplaincies, of which there are many. The Navy, Army and the Diplomatic Service offer chaplaincies, and there are School chaplains, Prison chaplains, Workhouse chaplains.

A candidate for chaplaincy in the Navy is required to be in Priest's Orders, and as a rule to be not over thirty years of age. Application should be made to the First Lord of the Admiralty.

Army chaplains are appointed by the War Office ; and though most of them are Church of England priests, there are also chaplains of other denominations. The Prison chaplains receive their appointments through the Prison Commissioners at the Home Office.

There are also appointments on the *Indian Ecclesiastical Establishment*, particulars of which are obtainable from *The Secretary of State for India, India Office, London, S.W.*1. To become a *Missionary*, the candidate should make application to the secretary of the particular missionary society he desires to serve.

The *Roman Catholic Church* recruits its priests from schools that are solely of its own denomination, and a very strict course of study is prescribed for the candidate. Candidates should consult either their parish priest or bishop as to the ways and means available for entering the priesthood.

Congregationalists specify that candidates for the pastorate shall first receive the hearty recommendation of the pastor and church to which they belong. They must then submit to a preliminary examination. Altogether the Congregationalists have about twelve training Colleges in the United Kingdom.

Wesleyans recruit their ministers from the ranks of the local or lay preacher. There are several Wesleyan Theological Institutes for training, and it should be pointed out that Wesleyan ministers are changed from place to place every three years, and that furnished houses are usually provided rent free.

Marriage is usually permitted to a minister only after full ordination ; but an allowance is made for the support of children, and there are also pensions for ministers.

Baptists have several colleges for the training of candidates. *Presbyterians* also prescribe their own course of training for candidates ; but a great many of our Scottish ministers are trained at the theological colleges at the various Scottish Universities.

Each of the other denominations has its own system of selection and training, particulars of which are obtainable from pastors and ministers.

Many earnest Christian men and women make the *Salvation Army* their life's work, and an intending candidate might apply locally for guidance or direct to the *Chief of Staff, the Salvation Army, Queen Victoria Street, London, E.C.*1. There are also openings for workers in the *Church Army* (*Headquarters : 55, Bryanston Street, London, W.*1.) and in the *Young Men's Christian Association* (*Headquarters : Russell Square, London, W.C.*). There is also the *Young Women's Christian Association*, with many branches and hostels.

In conclusion we would once more reiterate the point that religious effort can be made into a great and glorious career, but before deciding to take such a step the young man or woman should realise that the ministry is indeed something more than a career or a profession. The work should not be undertaken unless the candidate for Holy Orders is convinced of his special vocation.

A. C. M.

BOOK-KEEPING.—XV

Specimen Petty Cash Book and Notes on Partnership

In order that the student may better understand the exact nature of the "Imprest" system of keeping a petty cash book as explained in Lesson XIV, we now give an example showing how the series of transactions would be entered.

Assume that you are a junior clerk in charge of the petty cash, and that on the 1st April the chief cashier has handed to you for petty cash disbursements the sum of £10. Your various payments during the month of April are as follows :—

				s.	d.
April	1	Paid	for taxi fares . .	3	6
,,	3	,,	,, gummed labels .	5	0
,,	9	,,	,, pens, ink and fools-		
,,			cap . .	10	0
,,	10	,,	,, cartage . .	11	0
,,	16	,,	,, gum . . .	1	0
,,	18	,,	,, paste . .	0	6
,,	19	,,	,, office cleaning .	5	0
,,	23	,,	,, postage stamps .	10	0
,,	25	,,	,, cartage . .	8	6
,,	26	,,	,, tram fares . .	0	9
,,	29	,,	,, advertisements .	10	6
,,	30	,,	,, postal orders (2)	15	2
				£4	0 11

These transactions are entered as follows :—

The petty cash book (*below*) illustrates completely the practice followed when the imprest system is in operation. The £4 0 11d. which has been spent is refunded on the 30th April, so that on May 1st there is again the sum of £10 cash in hand.

In practice the form will vary with the requirements of the business to which it is applied, the headings of the analysis columns corresponding to classes of payments which it is desired should be kept together. In some cases the names of the persons or firms to whom the payments are made are also recorded.

Opinions may differ as to the best method of carrying the items from the petty cash book to the ledger, but we consider the following represents the position most clearly :—

(1) Credit the general cash book with the sum advanced to petty cash (£10).
(2) Open and debit a petty cash account in the ledger with this amount.
(3) Credit petty cash account with the total expenditure (£4 0s. 11d.).
(4) Debit each of the expenses accounts with its respective total as shown by each column in the petty cash book.
(5) Again credit general cash book and debit petty cash account with the second amount advanced (£4 0s. 11d.), so that the £10 in hand will still be shown.

In this way the petty cash book is merely in the nature of a memorandum and the

PETTY CASH BOOK

Cash Received £	s.	d.	*Date*		*Particulars*	*Total* £	s.	d.	*Travelling* £	s.	d.	*Postage and Stationery* £	s.	d.	*Cartage* £	s.	d.	*Advertisements* £	s.	d.	*Sundries* £	s.	d.
10	–	–	Apl.	1	To Cheque																		
			,,	1	By Taxi fares	–	3	6	–	3	6												
			,,	3	,, Gummed labels ..	–	5	–				–	5	–									
			,,	9	,, Pens, ink and foolscap	–	10	–				–	10	–									
			,,	10	,, Cartage	–	11	–							–	11	–						
			,,	16	,, Gum	–	1	–													–	1	–
			,,	18	,, Paste	–	–	6													–	–	6
			,,	19	,, Office cleaning ..	–	5	–													–	5	–
			,,	23	,, Postage stamps ..	–	10	–				–	10	–									
			,,	25	,, Cartage	–	8	6							–	8	6						
			,,	26	,, Tram fares ..	–	–	9	–	–	9												
			,,	29	,, Advertisements ..	–	10	6										–	10	6			
			,,	30	,, Postal Orders ..	–	15	2				–	15	2									
4	–	11	,,	30	To Cash	4	–	11	–	4	3	2	–	2	–	19	6	–	10	6	–	6	6
					By Balance c/d ..	10	–	–															
£14	–	11				14	–	11															
£10	–	–																					
			May	1	To Balance b/d																		

petty cash account in the ledger will appear as follows :—

PETTY CASH ACCOUNT

		£	s.	d.			£	s.	d.
Apl. 1	Dr. to Cash	10	–	–	Apl. 30	Cr. by sundry payments	4	–	11
„ 30	Do.	4	–	11		by Balance c/d ..	10	–	–
		14	–	11			14	–	11
May 1	To Balance b/d	10	–	–					

In former lessons we have shown only the books of a sole trader, and even in the chapter on Joint Accounts the two persons introduced were working together for a very limited period, and for a fairly well-defined object. Although they were, from a book-keeping point of view, trading together for a particular venture, they were not partners in the ordinary sense, but each was trading separately on his own account.

Partnership Accounts

The combination of two or more persons permanently in a business is either some form of company or a partnership. Companies will be explained fully in later lessons ; in this and the next lesson we shall confine ourselves to partnerships.

Before treating of the accounts of partnerships, it is desirable that some attention should be given to the law relating to the subject. Partnership has already been defined as the relation which exists between two or more persons carrying on business together with a view to profit. For carrying on a banking business no partnership may consist of more than ten persons, and in every other kind of business the number is limited to twenty.

The persons who trade together as partners are collectively called a *firm*, and the name under which they trade is called the "*firm name.*"

Although it is possible for a partnership to exist without any definite written agreement, it is generally the custom to have the conditions embodied in a legal document known as the **Articles of Co-partnership.** In this document are set forth the terms and conditions agreed upon by the partners.

Partners may be :—

(1) **Active** as opposed to **dormant,** or sleeping. An active partner, as the name implies, is one who takes an active part in the business, whilst a dormant, or sleeping partner is usually one who, whilst financially interested in the business, takes no part in its working.

(2) **General** as opposed to **Limited.**—A general partner is one who contributes capital and service, taking his share of the profits, and ready to bear his share of any loss or liability, whilst a limited partner is one whose liability in the firm is limited to the amount of capital he has contributed. A limited partner takes no part in the active operations of the firm.

(3) **Nominal** or **ostensible.**—Consisting of those who, by their conduct towards third parties hold themselves out as partners and incur a consequent liability.

All partners (with the exception of Limited partners) are liable not merely to the full extent of their capital in the business, but each partner is jointly and severally liable to contribute to the full extent of his private property to enable the firm as such to meet its liabilities.

Liability of a Firm

The firm is liable for all acts done by its partners in the ordinary course of business or for the preservation of the business unless such acts are specifically forbidden by the partnership agreement. A partner must not carry on any other business without the consent of the other partners, nor must he withhold from his partners information concerning the firm and its operations.

The following provisions of the Partnership Act of 1890 which apply in the absence of any agreement are well worth careful study.

(1) All partners are entitled to share equally in the capital and profits of the business, and must contribute equally towards the losses of the firm whether of capital or otherwise.

(2) The firm must indemnify every partner in respect of payments made and personal liabilities incurred by him :—

(*a*) In the ordinary and proper conduct of the business of the firm ; or,

(*b*) In or about anything done for the preservation of the business **or** property of the firm.

(3) A partner who makes, for the purpose of the partnership, any actual payment or advance beyond the amount of capital he has agreed to subscribe, is entitled to interest at the rate of 5 per cent. per annum from the date of the payment or advance.
(4) Before profits have been ascertained a partner is not entitled to interest on the capital he subscribes.
(5) Every partner may take part in the management of the partnership business.
(6) No partner shall be entitled to remuneration for acting in the partnership business.
(7) No person may be introduced as a partner without the consent of all existing partners.
(8) Any difference arising as to ordinary matters connected with the partnership may be decided by a majority of the partners.
(9) The partnership books are to be kept at the place of business of the partnership (or the principal place if there is more than one), and every partner may, when he thinks fit, have access to and inspect and copy any of them.

The ordinary trading books of a partnership are kept in the same way as those of a sole trader, the essential difference being in the accounts which concern the capital and the distribution of the profits. It is obvious that there must be a separate capital account for each partner.

Capital Accounts

Suppose, for example, that A. and B. are in partnership; the Balance Sheet showing an excess of assets over liabilities to be £3,000. It is agreed that A. and B. shall have equal shares in the capital and profits of the firm. Two capital accounts will be opened, and each will be credited with the sum of £1,500. There will also be two current or drawing accounts which are debited with the amounts withdrawn by each partner.

If the profit made by the firm amounts to £500, each partner's account will be credited with half that amount, and this division will be shown in the Profit and Loss account.

Then the capital account of each partner will also be shown separately in the Balance Sheet. These and other points relating to partnership accounts will be dealt with more fully in the next lesson.

Definitions of Terms

Mortgage.—An agreement whereby a person pledges his property as security for money he proposes to borrow. The borrower is the MORTGAGOR, inasmuch as he mortgages his property, and the lender is the MORTGAGEE.

Mortgages are of two kinds, namely:—

Legal.—A legal mortgage is created where the owner of property in his own right transfers the property by deed to the mortgagee. The mortgagee receives the title deeds, and undertakes on repayment of the loan to re-convey the property and deliver up the title deeds.

Equitable.—An equitable mortgage is the mortgage of an interest in property where the mortgagor either deposits deeds without a conveyance, or conveys his interest, not being entitled to deeds.

Bankers' Lien.—A lien is the right to hold a person's property until payment of a debt is received. A lien does not, however, give the banker any right to sell the property, and legal advice should be obtained before dealing with securities held by way of lien.

A banker has a lien upon all negotiable securities deposited with him in his capacity as banker, by custom, unless there is an express contract, or there are circumstances showing an implied contract inconsistent with the lien. The lien is not affected by reason that the negotiable securities do not belong to the person depositing them if the banker is unaware of the fact.

A banker has no lien on securities which are deposited for some particular purpose. For example, it has been held that where a conveyance of two separate properties was deposited, with a memorandum of charge upon only one of the properties, the banker had not a general lien upon the other property.

Adjudication Order.—An order made by the Court of Bankruptcy, by which a person is adjudged a bankrupt and his property vested in a trustee for the benefit of the creditors. This order is made on a creditor's petition after the debtor has appeared before the Court and been publicly examined as to the cause of his insolvency; but the Court may be induced to adjudge a debtor a bankrupt even when the creditors have come to no decision on the matter, or if the debtor himself applies for an Adjudication Order before his public examination.

F. H.

THE GRAND CAÑON OF COLORADO.

The Colorado River, acting like a huge saw, has, in the course of centuries, cut nearly vertically through an enormous thickness of stratified rock and formed a cañon some 200 miles long, 5—12 miles wide, and 6,000 feet in depth. (*See page* 355.)

Continued from page 257.

ENGLISH LANGUAGE AND LITERATURE:

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EIGHTEENTH CENTURY POETS.—II

WHEN Goldsmith died in 1774, at the early age of forty-six, worn out by harassing, badly-arranged labours and foolishly incurred troubles, he left a weeping retinue of those whom he had befriended, and debts amounting to two thousand pounds. Johnson, who felt none of the jealousy cherished by his satellites, summed up the position in a large-hearted tribute—" Let not his frailties be remembered, he was a very great man."

Percy and Macpherson

A reversion towards the romantic poetry of earlier centuries received a great impetus through the work of Dr. Thomas Percy, who was born in 1729, became Dean of Carlisle in 1778, and Bishop of Dromore in 1782. By his *Reliques of Ancient English Poetry*, a republication, in 1765, of songs, ballads, and lyrics, partly taken from an old manuscript with which a maid was about to light a fire in a friend's house, Percy fairly won a place in the circle of literary notabilities dominated by Johnson and Goldsmith.

His chief literary work was done while he was a Northamptonshire vicar. Though he was criticised for treating his material with editorial freedom, altering, suppressing, and expanding at will, Percy had the warrant of literary taste and expertness, and not only popularised the forms of poetry he re-introduced, but greatly stimulated research. He died in 1811, after serving his Church as honourably as he served literature. Half a century after the publication of the *Reliques* Wordsworth declared that by them our country's poetry had been " absolutely redeemed."

Percy's thoughts were turned in his earlier years to ancient poetry by the success of one of the most curious of literary frauds—the pretended translation into English from Gaelic, by a Highland schoolmaster, James Macpherson, of supposed epics, preserved in remote parts of western Scotland.

Macpherson was born in 1736, the son of an Inverness-shire farmer. In 1760 he published what purported to be translations of *Fragments of Ancient Poetry;* and during the next three years added *Fingal*, an epic in six books, and *Temora*, an epic in eight books. These works told of the heroic deeds of a third-century Gaelic chieftain, Fionn, or Fingal, the narrator being the poet Ossian, the hero's son. The scenic setting is that of the western Highland, wild and weird, and the crooning of Celtic sadness is almost unceasing.

Accepted as a kind of elemental poetry, the Ossianic epics became known throughout Europe. But Macpherson could not respond to the demand of the critics, of whom Johnson was the sturdiest, for the production of the original poems. Many, however, believed, and the poet netted £1,200, went to London, became first a pamphleteer and ministerial scribe, then the London agent of an Indian nabob, an office which brought him a fortune and enabled him to sit as a Member of the English Parliament for the last sixteen years of his life.

Napoleon's Favourite Poems

He died in 1796, and, in accordance with directions in his will, was buried in Westminster Abbey. The cleverness with which he sustained the most successful of all literary insincerities cannot be denied. He countered his critics with a show of indignant pride. In Johnson's case he threatened personal violence, but the stalwart doctor bought a thick stick and dared him to make good his threat. There is significance in the

fact that the effusions of Ossian were Napoleon's favourite poems.

Macpherson's bogus antiques were probably one of the causes of another attempted deception of that period, namely, the forgeries of a young Bristol clerk, Thomas Chatterton, who wrote poems which he attributed to a supposed fourteenth-century monk, Thomas Rowley, and said had been found in an ancient parish chest in the beautiful old church of St. Mary, Redcliffe. Chatterton's father, grandfather, and great-grandfather had successively held the office of sexton in the church, and were followed by his uncle, the father having died before the birth of the boy in 1752.

The church had been rifled of many parchment records, and Chatterton, who in boyhood almost lived within its walls, came into possession of a number of these discarded treasures. Both as a precocious schoolboy and while engaged as a lawyer's clerk he imitated these ancient documents, and produced poems apparently old that deceived people inexperienced in research.

In his eighteenth year the lad went to London to try to make his living as an author, but, failing to support himself by his pen, committed suicide in a fit of despairing pride. He was only seventeen years and ten months old. No writer so young as he ever showed clearer evidence of poetic genius.

William Cowper—

The most potent influence towards simplicity in English literature in the later decades of the eighteenth century was the unaffected verse of William Cowper. In subject, feeling, and style Cowper broke away from the artificiality which had placed the Muse in fetters.

He was one of the few poets who have begun to write seriously late in life. His first volume of verse was published when he was fifty-one, and his best work when he was fifty-four. It is questionable whether he would have been more than a scholarly fugitive scribbler if his friends had not urged him to write as a means of staving off recurring fits of suicidal melancholy. One of the gentlest of mankind, when in fair health he radiated a captivating humour, but his mental affliction, arising out of religious fears, makes the story of his harmless life inexpressibly sad.

Born of a family of good social standing he was educated at Westminster School, called to the Bar, and at the age of thirty-two was offered a clerkship in the House of Lords, but the nervous strain of contemplating this employment drove him out of his mind, and at intervals during the rest of his life, which closed in 1800, in his sixty-ninth year, he was subject to periods of insanity. Through the generosity of his friends, he was able to live quietly in the country.

For twenty-seven years he lived in the neighbourhood of Olney, in Buckinghamshire. To the *Olney Hymns*, published in 1779, Cowper contributed 67, and the vicar, the Rev. John Newton, 281. Some of these hymns, by both writers, have been included in every modern collection. "God moves in a mysterious way," and "Oh, for a closer walk with God," are instances from Cowper, and "How sweet the name of Jesus sounds," and "One there is above all others," from Newton. It is generally held that Cowper's close association with Newton was harmful, inasmuch as it led to a disturbing religious introspection.

—The Apostle of Simplicity

His secular friends induced him to turn his thoughts outward, and in 1782, he published a volume of rhymed satires, lightly and gracefully touched, with interwoven passages of serious thought, on such subjects as error, truth, hope, charity, conversation, and retirement.

In 1785 appeared *The Task*, in Miltonic blank verse, but without Milton's dignity of tone, a delightful survey of simple English life, indoors and out of doors, as Cowper saw it, with a background of quiet scenery under the changes of the year. The plan of writing on familiar things, a task set by a lady visitor, allowed of the introduction of almost any topic, and all the poet's themes served to display the sweetness of his nature and the humanity of his views, while his patriotism and love of liberty gave him influence with thinkers as a public man, though he was a recluse.

The range of Cowper in subjects and style was not restricted to his longer works. In his 1782 volume appeared the vigorous *Ode to Boadicea*, and the sympathetic verses supposed to be written by Alexander Selkirk, the original Robinson Crusoe, while *John Gilpin* appeared anonymously in the same year. The pathetic *On the Receipt of My Mother's Picture* was published shortly before the poet's death, though written earlier. *The Loss of the Royal George* was given to the world later, with some of the subtly understanding poems on animal life which entitle Cowper to be regarded as the original inspirer of the kindness to animals movement.

Besides being a true poet, as far as feeling,

expression of genuine feeling without imaginative power can be said to create poetry, Cowper was an inimitable letter-writer. In verse or prose his writing gives the impression of complete sincerity and unaffected ease.

As an illustration of the style of Cowper's first book of poems we may take, in the section on Truth, his contrast between Voltaire and the simple religion of the peasant—

The path to bliss abounds with many a snare;
Learning is one, and wit, however rare.
The Frenchman first in literary fame,
(Mention him, if you please. Voltaire? The same.)
With spirit, genius, eloquence supplied,
Lived long, wrote much, laughed heartily, and died.
The scripture was his jest-book, whence he drew
Bon mots to gall the Christian and the Jew.

* * *

Yon cottager, who weaves at her own door,
Pillow and bobbins all her little store:

From the portrait by Thomas Phillips, R.A.; by permission of John Murray, Esq.

GEORGE CRABBE (1754–1832).

A simple man who found true poetry in the passions and sorrows of simple lives.

Content, though mean; and cheerful, if not gay;
Shuffling her threads about the live-long day,
Just earns a scanty pittance; and at night
Lies down secure, her heart and pocket light.
She, for her humble sphere by nature fit,
Has little understanding, and no wit,
Receives no praise; but though her lot be such,
(Toilsome and indigent) she renders much;
Just knows, and knows no more, her Bible true—
A truth the brilliant Frenchman never knew;
And in that charter reads, with sparkling eyes,
Her title to a treasure in the skies.

From *The Task* we cannot choose a more characteristic extract than the outburst on Slavery, with which the Second Book opens. At that time it had been decided legally that no slave could be owned in England.

From the portrait by George Romney.

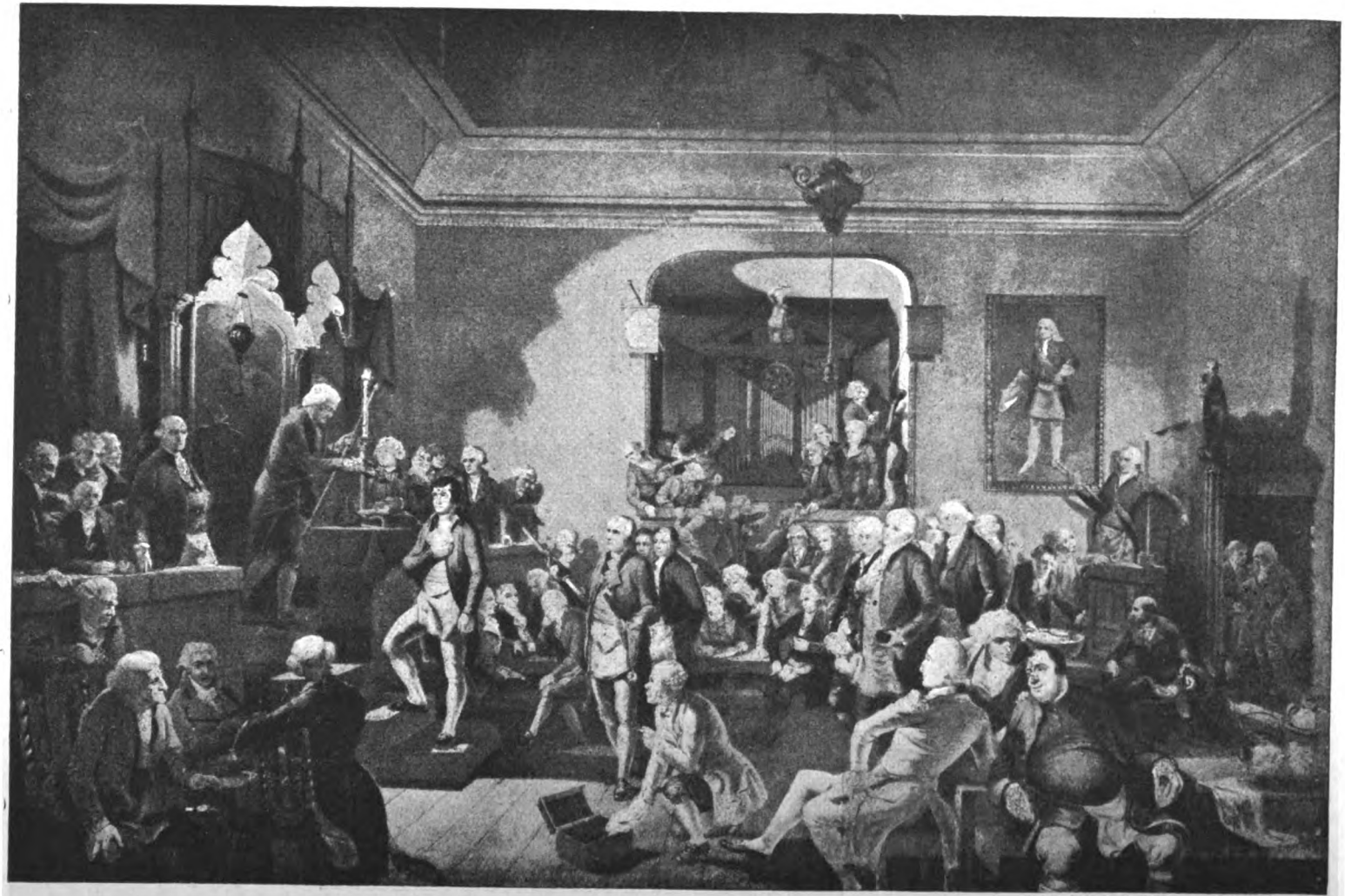
WILLIAM COWPER (1731–1800).

One of the few poets who have begun to write late in life; he published his first volume of verse when he was 54.

Slavery, however, remained a Colonial institution for more than fifty years.

Oh for a lodge in some vast wilderness,
Some boundless contiguity of shade,
Where rumours of oppression and deceit,
Of unsuccessful or successful war
Might never reach me more. My ear is pained,
My soul is sick with every day's report
Of wrong and intrigue with which earth is filled.
There is no flesh in man's obdurate heart.
It does not feel for man; the natural bond
Of brotherhood is severed as the flax
That falls asunder at the touch of fire.
He finds his fellow guilty of a skin
Not coloured like his own; and, having power
To enforce the wrong, for such a worthy cause
Dooms and devotes him as his lawful prey. . . .

William Blake, the first poet of childhood, brought simplicity in verse to a perfection never surpassed. He was born in London in 1757, and because of his boyish love of art was apprenticed to an engraver, a craft which he united with wildly imaginative painting. Out of a religious enthusiasm peculiar to himself he wrote, all his life, mystical works in prose and verse, which he illustrated in a weird and fantastic style. In his *Poetical*



THE INAUGURATION OF ROBERT BURNS

as Poet Laureate of the Lodge, Canongate-Kilwinning, Edinburgh, in 1787.

From the painting by Stewart Watson in Freemasons' Hall, Edinburgh; by permission of the Grand Lodge of Scotland.

Sketches (1783), echoes from the melodies of Spenser, Collins and other poets, he showed fine command of the music of words, and in *Songs of Innocence* (1789), and *Songs of Experience*, attained a lyrical glamour unique in our literary history. The *Songs of Innocence* are an overflow of sheer joy. The *Songs of Experience* grow more mystical and disputative. Blake lived with his visions on the edge of poverty till his seventieth year, dying in 1827 in the pure belief that—

> Where Mercy, Love, and Pity dwell,
> There God is dwelling too.

George Crabbe, who was born in 1754, at Aldeburgh, Suffolk, and died at Trowbridge, where he was vicar, in 1832, was a transition poet. In style he belonged to the school of Pope, but the subject matter of his poems was as far removed as could be from Pope's literary philosophism amid town society and wits. "A Pope in worsted stockings," though often accepted as an apt description, misses the mark, inasmuch as the men were utterly unlike each other, except in their literary garb. George Crabbe set himself, throughout a long life, to describe, in Pope's favourite couplets, the lives of the rural poor, which were far outside the older poet's range of vision. Crabbe wrote about the life he knew, with his eye always on the object he was describing. The outcome is a unique series of pictures of countryside doings and characters: for novelists had not yet realised that "the proper study of mankind" is not Man, but men.

At first the poet qualified as an apothecary and doctor, then attempted literary work in London, till he reached a state of destitution. His fortune turned when he appealed to Edmund Burke, who found a publisher for his poem *The Library* (1781), and revised his *Village* (1783), which became instantly popular. Between the dates of these publications the poet took holy orders, and for many years was a dutiful country parson.

From the portrait by Alexander Nasmyth in the National Gallery of Scotland.

ROBERT BURNS (1759-96), the national poet of Scotland; perhaps no poet more naturally and completely represents his race.

From 1807 onwards he recommenced publishing some of the works he had been steadily writing—*The Parish Register* (1807), *The Borough* (1810), *Tales in Verse* (1812), and *Tales of the Hall* (1819).

All Crabbe's writings are of the same general character, whether they are descriptive or tell a series of stories. They picture rural life and character with a grim fidelity. The literary workmanship is curiously uneven; the prevailing tone drab and depressing; but there are passages of arresting power, and the poet helped to prove that true poetry may be found in the passions and sorrows of simple lives without the embellishments of romance.

Robert Burns, the national poet of Scotland, was born at Alloway, Ayrshire, January 25th, 1759. No poet of any land can be said to represent his race so naturally and completely as he represents the Scottish Lowlands. Through him Scotland, using her most familiar tongue, poured forth her heart in song. Other poets have staged for us the problems of human fate, probed the mysteries of religion, interpreted the ministries of Nature, outspread the blandishments of romance, formulated in their libraries the harmonies of language; but he put the most natural and intimate impulses of the common heart of man into the simple words of everyday life, with a logical grace that adds sweetest music to sincerest speech. He brings poetry to the people.

Burns, as a poet, is not an outcome of poetical evolution. He was not shaped by the poetry of the great line of bards, and he left no successors. What he did was to listen to the songs that had been floating for generations in the minds of the common people, and to find in them germs of suggestion, which his own poetic impulse expanded, transformed and glorified.

Mankind has reason to be grateful that Burns was a rustic of genius who knew the songs, the heart, and the speech of the

people. Whenever he stepped out of that world he became comparatively commonplace—like dozens of smaller poets.

His limitations in education and acquaintance with the world were his opportunity. They prevented him from straying from his essential work as the song-writer of common humanity, of Scottish humour, unblurred by paralysing conventions and literary formation.

Burns was the son of a very indigent small farmer. His education, picked up precariously in the midst of constant toil on the land, sufficed to give him a writer's skilful command of entirely adequate language. The essence of his education came to him with his study of the songs of his countrymen, particularly those of Robert Ferguson, Allan Ramsay, and the collections which were then being gathered and published. These songs he was always bettering and adding to as he followed the plough, or wrote in the loft where he slept.

By the time he was twenty-seven he had failed repeatedly in farming, had muddled his life by amatory wildness, and had written enough verse to make a substantial volume.

To this period belongs the romantic story of his secret betrothal to a dairymaid, Mary Campbell, best known as Highland Mary, the one girl who really captured the poet's fickle heart. But they never married, for only a short while after she and her lover had exchanged vows at a lonely spot on the Ayr, Mary died after nursing her brother through a fever which she herself caught.

The Kilmarnock Edition

Burns was now so perplexed by poverty and the complications of his love affairs, that emigration appeared to be the only method of cutting the Gordian knot of his entanglements. Before, however, leaving Scotland and his past for a fresh start in Jamaica, he published at Kilmarnock, in 1786, his *Poems Chiefly in the Scottish Dialect.*

Their success was immediate and immense. He became a social idol of the moment; was invited to Edinburgh and there much fêted. In February, 1787, he was installed as Poet Laureate at the Masonic Lodge, Canongate-Kilwinning, Edinburgh.

He published a second edition of his poems that made for him a profit of £500—about the sum for which a single copy of the Kilmarnock edition now sells; travelled round Scotland, and then returned to his farming, his new friends having failed to find him any public employment.

In 1788 he married, and next combined his farming with an appointment as exciseman. In 1791 he gave up the farm, and settled at Dumfries as an excise officer only. During his latest farming period he wrote some of his finest songs, including "Auld Lang Syne," also his inimitable "Tam o' Shanter." Openly averred sympathy with French republicanism hindered his official promotion, and his salary was but £90 a year when his health broke up and he died, July 21st, 1796.

Tam o' Shanter

Among Burns' longer poems the first place, by almost universal assent, is given to his humorous medley *Tam o' Shanter*, written with a sustained gusto that sweeps the reader along. There is the same verve and abandon in the coarser picture of *The Jolly Beggars.* The serious mind of the poet is best seen in the homely dignity of *The Cottar's Saturday Night.* His love of familiar animals runs through a number of his poems, and finds its most tender expression in his *Address to a Mouse*, whose nest had been upturned by the plough.

His strength in satire appears in his attacks on religious narrowness, and some of his personal "Addresses," while others evince his open-hearted friendship. But it is in his songs that the poet attains an inimitably perfect expression of the emotions that chased each other through his susceptible heart.

What other poet has created such an atmosphere of reminiscent love as Burns in his "To Mary in Heaven"? Who has thrown such a glow on friendship as he in "Auld Lang Syne"? Where else has fidelity through life's decline been pictured as in "John Anderson, my Jo"? What more manly strain has sounded in human speech than in "A man's a man for a' that"? And where else can such an exquisite note be heard as in the following appeal to "Mary Morison"?

O Mary, at thy window be,
It is the wished, the trysted hour!
Those smiles and glances let me see,
That make the miser's treasure poor.
How blithely would I bide the stoure,
A weary slave frae sun to sun,
Could I the rich reward secure,
The lovely Mary Morison.

Not one in all the pageant of the poets that have passed before us from Chaucer to the close of the eighteenth century, has, in such simple words, rung the clear chime of love as this self-educated Ayrshire ploughman.

J. D.

From the picture by James Archer, R.S.A. By permission of Messrs. Henry Graves & Co., Ltd.

BETROTHAL OF ROBERT BURNS AND HIGHLAND MARY

at a lonely spot by the Ayr. Highland Mary—a dairymaid named Mary Campbell—was the one girl who really captured the fickle heart of Burns. But unhappily for the poet she died shortly after their betrothal, after nursing her brother through a fever which she herself contracted.

PHILOSOPHY.—I

By many people the word "philosophy" is associated with interminable arguments about matters of no practical utility, and which lead to no tangible results. This pessimistic view of a great subject is in no small measure due to the misunderstandings which have arisen alike from the incapacity of the average man to comprehend abstract ideas, and from the inability of some philosophers to express their thoughts in simple and direct language. The philosophical vocabulary, moreover, at times becomes congested. The history of philosophy is replete with instances of the same words being used in different senses: "substance," "soul," "logic," "æsthetics," "*a priori*," and the word "philosophy" itself are cases in point. It is therefore incumbent upon every philosophical guide to make clear at the outset the meanings of some of the terms he employs.

IMMANUEL KANT (1724–1804),

an eminent and influential German thinker who may be said to have founded critical philosophy.

A philosopher was, originally, a contemplative as distinct from a practical "lover of wisdom," and, although the meaning has undergone many changes, it has always connoted something general or abstract, far removed from the practical thoughts and affairs of everyday life.

In describing any branch of knowledge, special emphasis is to be laid upon its object and its scope. *The object of philosophy*, in its wider sense, *is to obtain a complete and unified knowledge of reality, i.e. of that which is.*

This definition implies a relationship between philosophy and science which is accurate, ordered knowledge of events and things (called by philosophers "phenomena"). Science is the collective name given to various branches of knowledge, the so-called special sciences, each of which either deals with a certain class of phenomena, or regards them from a particular point of view. Thus, anthropology deals with man in his relation to the animal world; geology concerns itself with the changes of the earth's crust; biology treats of the phenomena exhibited by living organisms, and so on. These sciences have many points of contact with one another, but no one of them has for its subject-matter the totality of all things; that is the scope of philosophy.

If existence is a riddle, each separate science may contribute a clue, but philosophy alone, it is claimed, can provide the solution.

The aim of philosophy is thus to attempt the unification of all knowledge, to synthesise (i.e. build up) the facts and theories of the special sciences into one coherent whole; and when this task is accomplished, we may look forward to a complete understanding of the world around us. The truths of science are as the scattered beams of sunlight which the converging lens of philosophy is to concentrate and focus upon such recondite questions as the relation between mind and matter, the origin and validity of ideas, and the problem of right and wrong.

It may be that some of these problems are beyond the capacity of man to solve, but here philosophy itself, by defining the limitations of human knowledge, has the deciding word to say; and even if satisfactory solutions are unobtainable or unobtained, the sincere inquirer will not entirely lose the reward of his efforts; for like the "choice young man" of Israel who set out to find his father's asses, he may return rewarded with a kingdom, if not in the world of matter, in the more peaceful and enduring one of mind.

It follows from the above that every inquirer has the right to the name of philosopher who is conscious of the place of his own work and his own subject in its relation

to the whole world of thought and knowledge. It is a trite criticism that the specialist is all too prone to submerge himself in his own narrow study, and so to lose sight of its relation to the whole. Such a man may be an excellent scientist, but he can be no philosopher in the sense laid down above.

The word philosophy is also used in a narrower sense to connote certain special subjects which deal with matters of a more general and fundamental nature than are to be found in the special sciences.

Materialism and Spiritualism

All systematised human knowledge can be subdivided into the special sciences and the philosophical sciences. The latter include Metaphysics, Theory of Knowledge or Epistemology, Ethics, Æsthetics and Logic. Unlike the special sciences, their philosophical relatives do not concern themselves primarily with the world of objects, although all of these come within their province. Their mission is the more ambitious one of attempting to solve the "nature of reality," of investigating the limitations of human knowledge, of examining critically the fundamental assumptions of the special sciences.

Hence the two meanings ascribed to the word philosophy are not in nature dissimilar, for if the philosophical sciences succeed in solving their special problems, there will follow at that synthesis of human knowledge, that unified conception of the world of phenomena, which was stated to be the *raison d'être* of philosophy in its wider sense.

Metaphysics concerns itself with two main problems: the *ontological* and the *cosmological*.

Ontology deals with the nature of reality, i.e. with the relation between matter and mind. On the one hand, the world as we know it is composed of material objects in an incessant state of motion and of change; on the other, we have the phenomena of mind or consciousness—sensation, thought, will, emotion and desire.

How do these two groups of phenomena stand in relation to one another?

If we answer that matter is the fundamental reality, that the manifestations of mind or spirit are merely the attributes of matter and can be adequately explained in terms of it, we are *Materialists*. If, on the contrary, we affirm that the one and only reality is mind, that material objects exist only in our consciousness, we are called *Spiritualists* or *Idealists*.

Both Materialism and Spiritualism are *monistic*, or forms of *Monism*, because they seek to explain all phenomena in terms of *one* principle, i.e. either of matter or mind. The ordinary view that matter and mind are two distinct and fundamentally different realities is called *Dualism*.

Lastly, we may think with the *Sceptics* or *Agnostics* that the elucidation of the relation of matter to mind is impossible. Should we further aver that matter and mind are only different forms of one unknowable unknown, we have to bear the somewhat cumbrous title of *Monistic Agnostics*.

Thus ontology seeks to probe the *nature* of reality; *cosmology*, the second problem of metaphysics, endeavours to establish its *form*.

"The universe is a system composed of eternal and independent elements, by the combination of which all objects are formed." So says *Atomism*.

"To be sure," answers the *Theist*, "the visible world is apparently a vast concourse of atoms or independent units, but, in reality, all these individual parts originated from one source, were conceived by one designing intelligence, and are held together by one omnipotent power, which is the creator, the upholder and the arbiter of the fate of all things."

"Nay, not so," chimes in the *Pantheist*. "The force or power which holds all things together is not an external one, but is inherent in the things themselves. The universe is a self-contained animate whole, and its soul is present in each and every individual part; and thus the apparent diversity of phenomena fades away into the infinite azure of an harmonious whole."

Theory of Knowledge

Theory of knowledge, or epistemology, has also two principal questions to answer. The first deals with the *origin* of knowledge.

Empiricism maintains that all knowledge is derived from sensation, i.e. hearing, seeing, feeling, etc.; that experience is built up of combinations of sensations, and that we have no ideas which are independent of it.

The older *Rationalism* asserts that we have some ideas which are independent of experience—the so-called "innate" ideas.

That form of Rationalism which emanated from Kant seeks an answer to the questions: What *can* I know? What are the limits of human knowledge? What are the conditions that make experience possible?

It is willing to concede to Empiricism that sensation is the source of knowledge, i.e. that without sensations we could have no knowledge; but it affirms the existence of certain ideas or concepts which have an import and a validity which no amount of

experience could bestow upon them. The co-operation of these concepts with the elements of sensation produces knowledge and makes science possible.

It will be seen that such an inquiry is of fundamental and far-reaching importance; so important that some writers identify it with philosophy itself. It is, for example, of little avail to philosophise over the "nature of reality," if that problem is "behind the veil" of possible knowledge.

Those who entertain this view have, naturally, a poor opinion of metaphysics: they call it *l'art de s'égarer avec méthode* (the art of systematically going astray). They say that "metaphysics is not a science, but a cross between a religion and a fine art." Others compare it with the pastime of seeking in the dark for a black cat which is not there.

Those who hold this agnostic view do not thereby abandon philosophy as the means of unifying all knowledge, but they would exclude from its domain all traces of metaphysical and allied speculations.

The second question of epistemology discusses the relation between the external object and the conscious mind which perceives it.

Is our knowledge of the world a true image of the things themselves? Do we recognise objects exactly as they really are, or are our ideas of external phenomena of a totally different nature from that which really exists?

Experimental Psychology

The view that our knowledge is the exact counterpart of the real things is called *Realism;* the contrary doctrine, that we only know appearances and are completely ignorant of the things in themselves, is named *Idealism*, or *Phenomenalism.*

Psychology means, literally, the theory or account of mind, and as such is concerned in all branches of philosophy. That kind of psychology which deals with the phenomena of mind in their external or objective manifestations, and which is to a considerable extent capable of being investigated by the experimental method, is to be numbered among the special sciences; it is called Experimental Psychology. This science is becoming of increasing importance; it is, however, yet in its infancy, lacking the broad generalisations and unifying theoretical concepts which mark the older sciences.

Philosophical *Ethics* seeks to define the relation between good and bad with reference to human conduct and motives. It deals with the sense of duty, or, as it is also called, the moral consciousness, or conscience. It also strives to establish the ultimate end of conduct or action.

Utilitarianism says that good is that which is favourable to the life of the individual and of the community. *Intuitionism* distinguishes between good and bad more from the point of view of motives than from that of effects. Right and wrong are absolute, not relative; the sense of duty is the sole motive power of ethical conduct, and although its dictates are usually in harmony with the doctrine of "the greatest happiness of the greatest number," yet this utilitarian object is of secondary importance and must not be accepted as the criterion of right and wrong.

> "Because right is right, to follow right
> Were wisdom in the scorn of consequence."

The Highest Good

If we give our vote to the utilitarians, another question at once arises. What is meant by actions "favourable" to life? What is the aim and object of moral endeavour? *Hedonism* says it is feelings of happiness, which are not necessarily the same as feelings of "pleasure." A different view is that the practice of virtue is in itself the highest good.

Æsthetics, considered as a branch of philosophy, inquires into the nature of the beautiful and the sublime. What are the common attributes of things we call beautiful? To what extent is beauty subjective (resident in the subject, the observer)? How is the beautiful related to the good, as expounded by ethics, and the true as defined by epistemology and metaphysics?

Logic is called the "art of correct thinking." It is a *formal* science, having no direct connection with the facts or phenomena of existence; it merely furnishes us with the rules and regulations.

This cursory glance at the philosophical sciences must not lead to the impression that philosophy is divisible into water-tight compartments, for there are many points of contact and much overlapping between the different branches. All such classifications are more or less arbitrary, being devised by man for his own convenience. Nature is a continuity, i.e. is constituted of an unbroken series of events or phenomena, and the sharply-defined boundaries which man is prone to *read into* her, useful as they may be, are nevertheless but figments of his imagination.

E. H. T.

Continued from page 262.

HISTORY:

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THE RENAISSANCE

OF all the moments of history, none, perhaps, has more interest than the period known as the Renaissance, which found expression in a brilliant civilisation in Italy from about 1400 until it reached its zenith in France and England 200 years later. During that time the world underwent changes as momentous as any it had seen since the victory of Christianity and the fall of the Roman Empire.

The Renaissance—or rebirth—is indeed an apt name for the movement which marked the emergence of Western civilisation from the naïveté, the ignorance, the narrow ecclesiasticism of the Middle Ages to an age of enlightenment in which reason began to have a freer play, and learning and the sciences made giant strides. It is an age in which man finds himself, erect and proud, full of aspirations for mental and physical conquests, anxious to find expression for all his faculties, his mind and his body; no longer the frail, fallen mortal, subject to the limitations which the Papacy had for centuries set in his path.

Colonisation and Discovery

It was this sovereign need for expression, this search for truth in all its aspects, that characterised the great men of the Renaissance—many of whom combined, each in himself, the activities of poet, sculptor, painter, engineer, and scientist.

The need for emancipation was of course the real driving force of the movement—Nature reasserting herself after the rigid asceticism of the Middle Ages; reason seeking an outlet after its long imprisonment. But a series of extraordinary events reinforced this inner power, and they in themselves would have proved adequate, even if the soil had not been prepared, to fire men's imagination: the discovery of America, of Central Asia, and the Far East, of new worlds in the heavens, the discovery of the art and literature of Greek and Latin antiquity, and the invention of printing.

In 1492 Christopher Columbus, setting out to find beyond the Atlantic Ocean the eastern limits of Asia, discovered, instead, America. Later Balboa, standing on the heights of Panama Isthmus, gazed on the Pacific Ocean. Peru yielded its gold and silver treasures to Pizarro, and Cortez conquered Mexico. Vasco da Gama doubled the Cape of Good Hope and made discoveries in India. The era of colonisation had begun. On the great unoccupied territories of North America soon a new England, a new France and a new Spain would be founded, giving rise to a richer, freer society, unfettered by age-long prejudices, creating new institutions and forms of government.

Scientific Truths

Mediterranean ports, Vienna, Genoa, and later Marseilles, lost their importance, giving way to English, Spanish, Dutch ports. Commerce took a new direction; no longer confining itself to the Mediterranean, its course spread across the oceans.

New lands, new religions, strange races—negroes of Africa, redskins of America, yellow races of the Far East, unheard-of plants and animals—supplied fresh matter for the awakened intelligence to work upon. A great impetus was given to the sciences, natural history, physics and medicine.

Discoveries in the heavens were no less astonishing. In the middle of the fifteenth century Copernicus, the great Polish astronomer, wrote his *De revolutionibus orbium celestium*, in which the order of the universe, as we now know it, was elaborated for the first time.

Many years later Galileo, the Italian astronomer, was led to the same conclusions as those of Copernicus. He also boldly proclaimed the fact that the sun and not the earth was the centre of the

From the picture by Wehaert.

CAXTON EXAMINING THE FIRST PROOF SHEET

from his press at Westminster (1476). The invention of printing, by coinciding with, enormously stimulated the revival of learning. *(See also Vol. I., p. 326.)*

planetary system, and that the earth was one of the smaller members of the family of the planets revolving round the sun. This theory at once roused the hostility of the Church as being heretical and subversive of the faith. Galileo was summoned before the Inquisition, where he had to recant, on bended knee, these scientific truths.

But persecution failed to prevent their dissemination, and the earth, instead of being a unique world with the heavens immediately above it, became but a remote corner in an infinite universe; and the sky receded into measureless space.

To cope with these new facts the writings of mediæval thinkers were considered inadequate. Men turned away from the works of a Thomas Aquinas, or a St. Augustine; from the crude mystery plays and allegorical representations which were the stock-in-trade of mediæval literature. But what took their place? Here again the event proved equal to the occasion.

Greek Literature

In 1453 the Greek Empire came to an end with the taking of Constantinople by the Turks. The Greek scholars who fled westwards took along with them those precious manuscripts and sculptures which revealed in almost complete form the thought and art which constituted the Greek civilisation of the pre-Christian era: a world of thought of such a kind, moreover, that it seemed to meet half-way the ideas aroused by the geographical and astronomical discoveries.

The finding of a literature that so befitted the needs of the times led to a great revival of learning. Scholars devoted themselves with enthusiasm to reading and translating the manuscripts. The great cities of Italy became centres of education, and the Greek fugitives were often lodged in the palaces of the reigning princes. And over western Europe began to spread that culture which has exercised such a potent influence on modern thought and institutions.

The philosophy of Plato, the history of Thucydides, the scientific theories of Archimedes and Pythagoras, the drama of Sophocles and Euripides, not to mention the great writers, historians and poets of the Roman Empire, constituted a literature so universal in quality that it has ever since been the foundation of a liberal education.

The invention of printing coincided with the revival of learning, and gave it an unlooked-for completeness. Instead of being restricted to a few hundred scholars and monks and princes, the happy possessors of costly manuscript copies, the new learning was suddenly placed within the reach of tens of thousands of students. The new process originated at Mainz with the printers Schoeffer, Fust and Gutenberg; it was taken up in Venice and then in Flanders. It is said that Caxton learnt the art at Bruges "in a little room over the porch of St. Donat's" at the press of Colard Mansion.

The enthusiasm of the time being centred on Latin and Greek works, the printers paid small attention to mediæval writers. These remained for a long time buried and unknown in long cumbrous manuscripts, and the age to which they belonged became veiled in obscurity. In fact the invention of printing, occurring in the 15th century, practically suppressed the Middle Ages, while it linked up Greek and Latin thought with contemporary culture: and for some two centuries the Middle Ages were looked upon as a dark gap in the history of human thought—an age of darkness. This impression cannot find justification to-day; but it served to give greater point to the term Renaissance and a greater importance to the epoch than perhaps it in truth deserved.

Italian Art

The Renaissance found its earliest manifestations in Italy, mainly in painting and sculpture. In England it found expression chiefly through political and religious channels, and in France in the writings of moralists like Rabelais and Montaigne. Art, however, seemed to the Italians alone adequate to express the new ideas.

Italy was at that time much the most civilised country in Europe. Her commerce with the East had made her very wealthy, and her riches had engendered a love of luxury and encouraged the fine arts. Rome, Venice, Siena, Florence, Naples, had each its own splendid movement.

In Florence, Cosimo de' Medici, its illustrious ruler, could best please the populace, not by giving them circus games, as the Cæsars would have done, but by constructing churches and palaces and adorning them with the paintings of a Fra Angelico, the statues of a Donatello, or of a Verrochio. His leisure Cosimo loved to spend with his artists and sculptors, or with Greek scholars from Constantinople, and pay them lavish sums from the celebrated Bank of Florence.

Later, under Lorenzo the Magnificent, it is Leonardo da Vinci who, with Michael Angelo and Raphael in Rome, towers above them all. These extraordinary men are at once engineers, scientists, painters, sculptors,

architects. In their multitudinous activities and passionate energies they seem to be the incarnation of the spirit of the Renaissance. There was nothing in creation which Leonardo's curiosity would have him neglect. Experience to him formed the basis of knowledge, "Wisdom is the Daughter of Experience," and in that respect he prepared the way for inductive science. He invented flying machines, predicted steamboats. He played on a lute made by himself, according to laws of acoustics he had himself discovered. It is one of the great misfortunes of history that his sculptures should have been lost, and that of his paintings only few are extant: "The Last Supper," "Mona Lisa," "Adoration of the Magi," and some others.

Of Michael Angelo, the Dome of St. Peter's in Rome, the Tomb of Pope Julius II., the Christ carrying the Cross, are fitting monuments to his wonderful and stormy genius. His great painting of the newly created Adam on the ceiling of the Sistine Chapel in Rome has been taken as a symbol of the Renaissance, "of the time when man was, as it were, recreated more glorious than before, with a body naked and unashamed, and a strong arm, unimpaired by fasting, outstretched towards life and light."

Rabelais and Montaigne

This glittering civilisation of Italy exercised an immediate influence on that of France. The expeditions of the French into Italy, under Charles VIII., Louis XII., and Francis I., brought the French into direct contact with the splendour of Italian society. The elegant palaces, the gardens, the statues and paintings stood in marked contrast to their fortified castles, with their dark and forbidding look.

On leaving Italian soil the French kings took back with them architects and artists who should build them similar beautiful buildings. Francis I. induced Leonardo da Vinci, Andrea del Sarto and Benvenuto Cellini to come to France; and the palace of Fontainebleau and the wonderful châteaux on the Loire are the creations of his munificent reign.

Though the French Renaissance can boast of no great sculptors or painters of the first order, it can claim two outstanding names in literature, François Rabelais and Michel de Montaigne, two writers steeped in the new learning, expressing each in his own characteristic way the emancipation of the individual from the trammels of ignorance, of superstition, of ecclesiastical and civil authority; the former with his *fais ce que voudras* (do what thou wishest) proclaiming a joyful acceptance of life, and the latter with his *que sais-je?* (what do I know?) showing a serene and smiling front to the dogmatism and bigotry of the schools.

In England the Renaissance took the form of a movement with particular and well-defined aims. The new ideals were understood in terms of their practical bearings on society and politics, on religion and education.

Renaissance in England

John Colet, one of the chief figures of the English movement, returned from Italy without the artistic and literary preoccupations of Florence. What he brought back to Oxford was his knowledge of Greek, with which he intended, by unlocking the gospels and the New Testament, to restore Christianity to its early simplicity. He declared for a sound, grammatical reading of the Biblical text, clearing away the web of dogma and creed with which the schoolmen of the Middle Ages had obscured its meaning.

Colet devoted his energies to educational as well as religious reform. He laid the foundation of the system of grammar schools established by Edward VI. and Queen Elizabeth—schools which ever since have been an important factor in the life of the English middle class. His instruction aimed at the diffusion of a rational and simple Christianity, and the assimilation of Greek and Latin culture. No less a person than Erasmus, a European scholar of great note, lent his abilities to the achievement of Colet's work.

The reforming movement made its power felt also in the universities. Erasmus, who was for a time lecturer at Cambridge, describes the change in the following words: "Scarcely thirty years ago nothing was taught here but the *Parva Logicalia*, Alexander, antiquated exercises from Aristotle. As time went on better studies were added, mathematics, a new or, at any rate, a renovated Aristotle and a knowledge of Greek literature. What has been the result? The University is now so flourishing that it can compete with the best universities of the age." (1516.)

Henry VIII. occupied the throne of England at this time. His enthusiasm for the New Learning, his attainments and scholarship, supplied a fresh stimulus to the movement. Among his counsellors and diplomatists he favoured Sir Thomas More, the author of "Utopia."

In this work the spirit of the Renaissance

becomes critical: it turns to question the validity of social and political institutions. The social injustice, religious intolerance and political tyranny of existing society are condemned, and a vision of a commonwealth based on principles of equality, freedom and brotherhood is described.

The poets and writers of the English Renaissance ranked as high and as brilliantly as the artists of Italy. One indeed rose to such greatness that his work must transcend all epochs. The Elizabethan drama belongs to the English Renaissance, but can Shakespeare be said to be the child of any movement? His imagination had the same wide sweep as Leonardo da Vinci's. He evoked the past into life: he ranged from ancient times to the contemporary: with an equally master hand he passed from the imperial struggles of a Julius Cæsar to the realms of phantasy of a Prospero, or the more intimate, the more eternal conflict of the human soul in Hamlet.

Edmund Spenser, the Elizabethan poet, who wrote the great romantic epic, *The Faery Queen*, should be mentioned, and also Sir Francis Bacon, the precursor of modern scientific thought. Raleigh, Drake and Hawkins continued the work of the Spanish and Portuguese seamen: in colonisation and discovery, Britain was finally to gain the foremost place.

T. P. E.

From the picture by F. Cadogan Cowper, A.R.A., R.W.S., in the Palace of Westminster.

THE NEW LEARNING IN ENGLAND.

Erasmus and Thomas More visit the children of Henry VII. at Greenwich, 1499.

Continued from page 276.

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CHEMISTRY.—XXII

Carbon and Carbon Monoxide.—Of all the elements, carbon is one of the most important, inasmuch as it enters into the composition of all living structures and because it is widely used by civilised man. Carbon is exceedingly widely distributed in nature, particularly in the combined state. Carbon dioxide is a normal constituent of the air, and is also found dissolved in natural waters. The vast deposits of petroleum oil, such as exist in Southern Russia and in Pennsylvania, are mixtures of hydrocarbons, and many minerals contain it in the form of carbonate.

In the free state it occurs as the diamond and graphite. Like sulphur, carbon exhibits allotropy. Diamond and graphite are crystalline allotropes, and the amorphous forms include charcoal, animal charcoal, lamp black, coke and gas carbon.

Carbon is a remarkably stable element, resolutely resisting change. At high temperatures, however, all its forms can be burnt, $C+O_2=CO_2$, and much heat is evolved in the combustion: hence the value of this element as a fuel. Heated out of air it remains unchanged, but at 3600° it vaporises without previously melting. Secondly, carbon is insoluble in all ordinary solvents. Melted iron and silver dissolve it, and according to the conditions of temperature and pressure, the element separates out on cooling either as graphite or as very minute diamonds. Thirdly, on account of its power of combining with oxygen at high temperatures, carbon is a good reducing agent, coal, coke and charcoal being particularly useful in this respect. Thus when a mixture of copper oxide and charcoal is strongly heated in a covered vessel, copper is left, the carbon uniting with the oxygen. $CuO+C=Cu+CO$; $2CuO+C=2Cu+CO_2$. The allotropy of carbon can be proved in a similar manner to that described for sulphur (Experiment LXII.).

The Diamond owes its value to its scarcity, its intense hardness—it is the hardest substance known—and its power of reflecting and refracting light. Most of the gems met with in commerce come from S. Africa or Brazil. In the natural state they occur in the earth, or in river-beds, and resemble small pieces of washing soda in appearance; they have to be cut and polished to make them presentable as precious stones. Boart and carbonado (black diamonds) are imperfectly crystallised forms which are used for polishing and for rock-drilling. Both black and white diamonds were found in the celebrated meteorite which fell near Cañon Diablo, Arizona, U.S.A. All diamonds contain traces of impurities, which are left behind as ash when they are burnt, but the best do not leave more than 0·05 per cent. of ash. When heated out of air to 2000°, the diamond swells up and changes into graphite, without losing or gaining weight. Its specific gravity is 3·5.

Graphite, black-lead or plumbago, is found in many localities, notably in Ceylon, Madagascar, Siberia and the United States. It occurs both in the crystalline and amorphous states, although the former is by far the more important. It is used for making pencils, plumbago crucibles and electric furnaces, as a lubricant, as a protective coating for iron work, for polishing gunpowder, and other purposes. Graphite is soft, solid, lustrous, smooth, and of sp. gr. 2·3; it is a good conductor of heat and electricity, particularly at high temperatures; on combustion it leaves much more ash than the diamond, the carbon content varying from 68-90 per cent. It is obtained artificially by heating coke or charcoal in the electric furnace.

Charcoal is produced in the destructive distillation of wood. The older process of charcoal "burning" consisted in piling wood into stacks with a central vertical channel to act as a flue, covering the heap with rods, and setting fire to some brushwood placed in the centre. The combustion is restricted by controlling the supply of air which enters through small holes at the base of the stack. This is a wasteful process, as many valuable products are lost in the escaping volatile matter; a more rational process is to heat the wood in kilns or retorts and to lead away and recover the valuable by-products. Among these products are, gases: hydrogen, marsh gas (CH_4), acetylene (C_2H_2) and oxides of

carbon; liquids: wood spirit (methyl alcohol), pyroligneous acid (acetic acid), acetone (a solvent) and wood tar. Whatever process be used, the residue consists of a dull, black solid of sp. gr. 1·45–1·70, called wood charcoal. Although heavier than water it floats upon it, being buoyed up by the air present in its innumerable pores. It is owing to the presence of these pores that charcoal absorbs—or, better, adsorbs—large quantities of gases. One c.c. of coconut charcoal adsorbs no more strongly. The smell of tarry matter and the escape of combustible gases are observed. After cool ng, the crucible is opened and a little wood charcoal is seen. Sugar charcoal may then be made in a similar way. (ii) A lump of wood charcoal is put into water: it floats. It is then weighted with a piece of lead foil and boiled under the water for some time. On detaching the metal, the charcoal is observed to float. (iii) A long narrow tube closed at one end is filled with mercury and inverted in a trough of the same liquid. Ammonia gas, obtained

SEARCHING TABLES, DE BEERS DIAMOND MINES, KIMBERLEY.

less than 170 c.c. of ammonia; but the adsorptive power varies with the kind of charcoal and diminishes as the temperature rises. When heated strongly in the air, charcoal glows, i.e., burns without a flame, forming carbon dioxide.

Animal charcoal or bone-black is the residue left when bones are heated out of air. In this case, also, some of the volatile products are valuable, e.g., bone oil and pyridine. Bone charcoal contains only about 10 per cent. of carbon in a porous state; the remainder is chiefly calcium phosphate which may be removed by dissolving it out with hydrochloric acid, and the product is then known as pure animal charcoal. Both it and blood charcoal have a porous structure and a high adsorptive capacity, particularly for colouring matters: hence animal charcoal is used for clarifying crude syrup.

Experiment LXIXA. — *Experiments with charcoal.*

(i) Some small pieces of wood are heated in a covered porcelain crucible, at first gently and then by warming the solution, is collected in the tube and the height of the mercury is noted. A small piece of wood charcoal is heated and then put into the tube; it rises to the surface, adsorbs ammonia, and the mercury level rises gradually. (iv) A coloured liquid, such as water containing charred sugar or a little indigo, is warmed in a flask and then shaken with animal charcoal. On filtering, the liquid will appear nearly colourless; if not clear the treatment may be repeated.

Lamp black is one of the purest varieties of amorphous carbon, containing only a very small amount of combined hydrogen. It is made by burning substances rich in carbon, e.g., tar, acetylene, turpentine, in a large chamber to which only a limited supply of air is admitted. The "soot" is deposited upon coarse "blankets" hung in the chamber. It is the chief ingredient of printer's ink, and is also used as a stove-polish and for boot-blacking.

Coal soot is used agriculturally as a top-dressing for the soil. Its efficacy is largely due to the

nitrogenous compounds contained in it, but the carbon itself increases the absorptive capacity of the soil for solar heat rays, and thus brings about a higher soil temperature.

Coke and *gas carbon* constitute the residue left in the fireclay retorts when coal is subjected to destructive distillation in the manufacture of coal gas. Coke is also made in specially constructed ovens or retorts, and in some cases the valuable volatile

From a photograph taken in the Natural History Museum, South Kensington.

IMPRINTS OF A FERN-FROND ON A PIECE OF COAL.

The fossil imprints of leaves can frequently be seen on specimens of coal.

products are collected. Hard coke is dark grey, compact, lustrous, withstands great pressure, and is used principally in metallurgical operations. Soft coke is black, brittle, porous and not easily ignited; it is used for the blacksmith's forge. There is usually about 90 per cent. of carbon in coke. Gas carbon is a hard, dense black mass of comparatively pure carbon which, owing to its property of being a good conductor, is much used for making the carbon rods of electric arc lamps, and for the positive poles of electric batteries and of electric and electrolytic furnaces.

Coal is sometimes regarded as a natural form of amorphous carbon. The amount of that element present in it varies from about 65 per cent. in the case of lignite or brown coal, to 90-95 per cent. in anthracite or steam-coal; bituminous or house-coal contains 75-90 per cent. of carbon. Although most of the carbon in coal is in the free state, some of it is combined with hydrogen, oxygen and nitrogen; in addition, silicon, aluminium, phosphorus, sulphur and iron (as iron pyrites) are always present. The universally accepted theory of the origin of coal is that it represents the residue formed by the carbonisation of vegetable matter by heat and by the pressure of superimposed deposits of sand and rocks. The fossil imprints of leaves can frequently be seen on specimens of coal.

The older the mineral, the more carbon does it contain and the greater is the heat of combustion. Thus anthracite is the best heat producer and lignite the worst. Coals also differ very much as regards the volatile matter they emit when heated; bituminous coals are the best in this respect and they are therefore especially useful for the production of coal gas. The incombustible matter left when coal is burnt contains silica, iron oxide and potassium carbonate; the gaseous products of combustion include carbon dioxide, steam, free nitrogen, and a little sulphur dioxide. The destructive distillation of coal yields three distinct kinds of products, *viz.* coal gas (containing about 50 per cent. of hydrogen, 35 per cent. of methane, the illuminating gases ethylene (C_2H_4) and acetylene (C_2H_2) and others); a liquid distillate, of which the lighter portion called "gas liquor" contains ammonia, and the heavier "gas tar," which is the source of a host of valuable commercial products; a solid residue of coke and gas carbon.

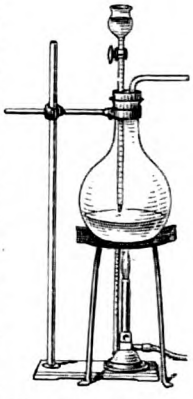


Fig. 36.—Laboratory apparatus for making carbon monoxide.

Hydrocarbons and Carbides.—Although generally very inert, carbon will combine directly with hydrogen, sulphur, and some metals under certain conditions. Acetylene, C_2H_2, is formed when the electric arc discharge is passed between carbon terminals in an atmosphere of hydrogen.

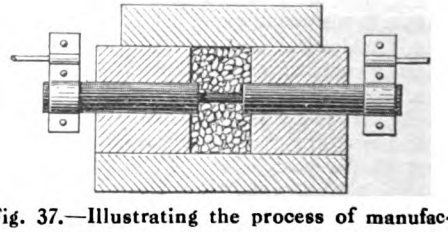


Fig. 37.—Illustrating the process of manufacturing calcium carbide by heating quicklime and powdered coke to a very high temperature in an electric arc furnace.

Most hydrocarbons are formed in indirect ways; there are an enormous number of them, and their study belongs to the province of Organic Chemistry, which is defined as the chemistry of the compounds of carbon. The name "carbide" is usually applied

to a compound of carbon with a metal. Calcium carbide, CaC_2, is the most important of these compounds; it is manufactured by heating quicklime and powdered coke to a very high temperature in an electric arc furnace, out of air. $CaO+3C=CaC_2+CO$ (Fig. 37).

It is a hard, brittle solid, white when pure, but the commercial product is grey. Acetylene is made by the action of water upon it, $CaC_2+2H_2O=C_2H_2+Ca(OH)_2$; and it is also used in the manufacture of the valuable artificial fertiliser, cyanamide, $CaCN_2$, by heating it in a current of nitrogen at 1200°. When cyanamide comes in contact with water it yields ammonia and calcium carbonate, both of which are active agents in promoting soil fertility; $CaCN_2 + 3H_2O = 2NH_3+CaCO_3$.

Carbon Monoxide.—Whereas carbon dioxide is the ultimate oxidation product of carbon, whether free or combined, a lower oxide, carbon monoxide, CO, is also formed when the oxidation is incomplete. Carbon monoxide also results when dioxide is reduced by passing it over strongly heated carbon. $CO_2+C=2CO$, and the blue flame often seen on the top of a bright fire consists of burning monoxide produced by the action of the red-hot coal upon the dioxide passing through it. The most convenient laboratory method of making carbon monoxide is by dropping a strong solution of formic acid into gently warmed sulphuric acid (Fig. 36) The formic acid is put in the tap-funnel, and it is run into the warmed sulphuric acid in small quantities at a time. The action may be regarded as one of dehydration: $H.COOH-H_2O=CO$.

Experiment LXX.—*To examine carbon monoxide.*

(i) A few jars of the gas are collected over water, in which it is only very slightly soluble. As the gas is very poisonous, and all the more dangerous because invisible, the experiment should be conducted in a good draught. (ii) A light is applied to the mouth of a jar; the residual gas is tested with lime-water, which turns milky. The monoxide does not affect lime-water. (iii) A lighted taper is plunged into the gas. (iv) The delivery tube is disconnected and in its place is put a small hard glass tube containing copper oxide. The tube is clamped horizontally and the oxide is gently warmed. Copper is formed, and if the gas which is then generated be passed into lime-water, turbidity is produced, as the student will readily note.

These experiments will show clearly that carbon monoxide produces carbon dioxide when it burns: that it is a non-supporter of combustion; and that it easily reduces copper oxide. The equations for (i) and (iv) are, respectively: $2CO+O_2=2CO_2$, and $CuO+CO=Cu+CO_2$. Carbon monoxide is sometimes made by warming sulphuric and oxalic acids together: $2\,COOH-H_2O=CO+CO_2$, but in this case it is contaminated with an equal volume of the dioxide, which can be eliminated by passing the mixed gases through caustic soda solution.

"Water-gas" is a mixture of equal volumes of carbon monoxide and hydrogen, obtained by passing steam through coke at 1000-1100°, $C+H_2O=CO+H_2$; it is used as a fuel and for reducing operations.

E. H. T.

TROPICAL VEGETATION IN CARBONIFEROUS BRITAIN.

Coal represents the residue formed by the carbonisation of vegetable matter by heat and the pressure of superimposed deposits.

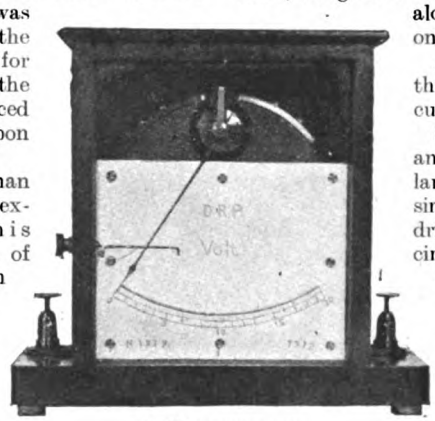
ELECTRICITY AND MAGNETISM.—X

Electrical Energy.—We have next to learn the relative practical values of apparatus used in the generation of current electricity. In order to do this, we must consider the important factors known as Electro-Motive-Force and Resistance, which determine the strength of an electric current. Electro-Motive-Force (E.M.F.), Resistance (R.), and Current strength (C.) are definitely related to one another, and each can be measured in definite units.

The energy of electrification was, in Lesson I, briefly compared with that of a man. A further consideration of the analogy may help us to understand the nature of E.M.F., R., and their relation to C. By means of a force pump a man could send a continuous stream of water through a series of pipes so arranged that the water returned to the reservoir from which it was pumped. The strength of the water current, and its capacity for performing work, such as the turning of a water motor placed in the circuit, will depend upon two factors:—

(1) The energy of the man operating the pump, or expressed differently, his ability to cause motion of water in the pipes, an ability which might be termed Man-Motive-Force.

(2) The nature of the pipes conducting the water along the circuit. The pipes themselves will offer some resistance to the flow of water, and should a water motor be placed in the circuit, the resistance will be increased.



A VOLTMETER.

The instrument for measuring, in units called volts, the E.M.F. of a current generating apparatus.

In the case of current electricity, the strength of a current will depend upon two analogous factors:—

(1) The pumping force of the cell, or, as it is termed, its Electro-Motive-Force.

(2) The nature of the wires, etc., conducting the current along the circuit; or, in other words, the Resistance that the total circuit offers to the passage of electricity.

Let us consider each of these factors in some detail.

Electro-Motive-Force. (E.M.F.)—In the case of the man pumping water certain facts are obvious. With a given unalterable series of pipes, the strength of the water current will be directly proportional to the Man-Motive Force. The stronger the man, the stronger the current. The length of time during which the water flows will depend upon his endurance. Should the man suffer from physical defects, faulty digestion for instance, his "motive-force" will be impaired, with consequent diminution of the strength and duration of the current. Even in the case of a strong man, the flow of water will cease when his strength has been so far reduced that he is unable to produce a difference of water pressure to overcome any form of resistance offered by the pipes, etc., forming the circuit.

An essential condition of a flow of water is the existence of a *difference in pressure*. The water at one end of the circuit must be at a higher pressure than that at the other end, and it is the function of the Man-Motive-Force to produce and retain this difference of pressure. Similarly, it is the function of the Electro-Motive-Force of any cell or other kind of generating apparatus to produce and maintain a difference of Electric-Pressure. The word "*potential*" is employed to designate "Electric-Pressure," hence we say that a difference of Potential is necessary for the production of a "flow" of electricity. The greater the E.M.F. of a cell, the greater the strength of a current flowing along an unalterable circuit, i.e., one having a fixed resistance.

Anything which tends to impair the E.M.F. of a cell weakens the current obtained from it.

Such defects as local action and polarisation in cells are similar to faulty digestion in a man, since they weaken the force that drives the current around the circuit. Concerning the duration of a current from any particular cell, electricity will continue to traverse the circuit until the E.M.F. has fallen so low that it is insufficient to overcome the resistance of the circuit.

Variations in E.M.F. are due to variations in the efficiency of the chemical reactions taking place in a cell. The origin and fluctuations of E.M.F. in the case of non-chemical apparatus, such as a dynamo, will be discussed in later chapters dealing with such machines.

The general relations between E.M.F., Resistance, and Current holds good no matter how the electric current may be produced, but for the present we are considering the origin of the E.M.F. of a cell. The chemical work taking place in the cell is an electric pump causing the positive plate (carbon) to be in a *different electrical condition* from that of the zinc or negative plate, and this difference in condition is termed Potential Difference (P.D.).

According to theories (see Lesson I) electricity is considered to be of two kinds—positive and negative—which are in equilibrium in any substance not electrically excited. In a cell, the chemical reactions destroy the electric equilibrium, the carbon plate becoming charged positively by the electro-positive hydrogen, and the zinc negatively as the result of its attraction for the electro-negative oxygen.

The circuit being complete, a current of electricity flows along it from the positively charged plate to the negatively-charged zinc, hence *the*

positive plate of a cell is said to have a potential higher than that of the negative plate.

The electro-motive-force of any kind of current generating apparatus is measured in practical units called *Volts* (after Volta), the measurement being made by passing the current through an instrument called a Voltmeter.

There are other units of theoretical interest, but we shall adhere to those used in actual practice.

Powerful dynamos often develop a voltage of thousands of volts, but that of cells is very low in comparison.

The following table indicates the Voltage of the cells already described (pp. 266-69), and it must be understood that the figures quoted denote the voltage of each cell when it is exerting its E.M.F. at the commencement of current flow :—

Cell.	Voltage.	Degree of Constancy.
Dichromate ..	.. 2·3 ..	soon falls.
Bunsen's ..	.. 1·9 ..	fairly constant.
Leclanché ..	.. 1·6 ..	soon falls.
Dry Cell ..	about 1·5 ..	fairly constant.
Daniell's ..	.. 1·1 ..	fairly constant.
Simple Cell ..	about 1·0 ..	rapidly falls.

The student who has purchased a dry cell, and constructed both simple and dichromate cells, may now observe roughly the constancy of the E.M.F. of the respective cells.

Experiment 31.—*To compare the constancy of the E.M.F. of different cells.*

Construct an external circuit consisting of two or three yards of thin wire, a portion of which should be wound once or twice around a small compass, as indicated by the figure.

Arrange the compass so that the needle and the wire around it are in the magnetic meridian. By means of books, or other non-metallic objects, secure the compass so that it does not move out of its

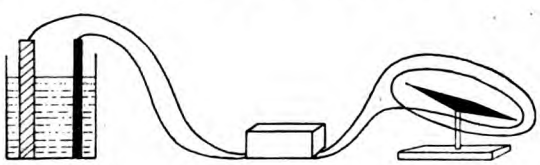


Fig. 37.—To compare the constancy of the E.M.F. of different cells.

position. Now connect the ends of the wires to the simple cell. Note the deflection of the compass, and the rate at which the needle moves backwards towards the meridian. This backward movement of the needle indicates a weakening of the current, and this may be due to one or both of two things—the decline of E.M.F. of the cell, or an increase in resistance of the circuit. Since the external circuit does not change, the deterioration is due to a decline in E.M.F.

Replace the simple cell by the dichromate cell, and later by the dry cell. In each case the rate at which the compass needle returns towards the meridian indicates the rate at which the E.M.F. of the respective cell declines.

Resistance.—We have seen that with a circuit of unalterable resistance the current is directly proportional to the E.M.F. of the generating apparatus.

Now let us consider what happens in the case of a constant E.M.F. driving a current along circuits of different resistances.

In the case of the man pumping a current of water, the size and position of the pipes have a great deal to do with the strength of the water current flowing through them. Narrow pipes will weaken the current more than wider pipes will do, provided the man-motive-force is constant. A water motor placed in the path of the water will also weaken the current. It is quite evident that *the current is a matter of man-motive-force versus the resistance offered by the complete water circuit.* Similarly in the case of an electric current *it is a question of E.M.F. versus R.*

A 2-Ohm coil—such as can be bought quite inexpensively from any electrician.

The resistance of an electric circuit depends upon its length, the nature of the material of which the wires, etc. are composed, and upon the thickness of such materials.

Small gauge wires offer greater resistance than those made of the same material but of larger gauge. A piece of electrical apparatus such as a motor placed in the circuit is so much additional resistance. With a definite unalterable E.M.F. the relation between resistance and current strength is stated thus : —

The current strength is inversely proportional to the resistance. The greater the resistance the weaker the current, and vice-versa.

Using the generally accepted symbols representing electro-motive-force, resistance, and current, we can express the relation between them by the equation :—

$$C = \frac{E}{R}.$$

(E. is a still shorter form of E.M.F.)

Resistance is measured in units called Ohms (after Ohm), and Ampères (after Ampère) are the practical units of current strength.

One Ohm is the resistance offered to the passage of electricity by a column of pure mercury 106·3 cms. long, and having a uniform cross section of one square millimetre.

Since temperature influences the resistance of conductors, the mercury must be at the temperature of melting ice if its resistance is to be exactly one Ohm. A coil of wire having, at the temperature of about 59½° F., a resistance equal to that of the stated column of mercury, is the Board of Trade Standard Ohm. For experimental purposes, coils of wire are made having resistances of 1, 2, 3, 5, and higher numbers of Ohms. A 2-Ohm coil can be purchased from an electrician quite inexpensively, and, if possible, the student should obtain one for use in later experiments.

The Board of Trade Ampère is that constant current which deposits silver at the rate of 0·001118 gram per second, when it flows through a solution containing a compound called silver nitrate. This matter will be understood better when we consider silver plating.

The relation between current, E.M.F., and resistance, represented by the equation

$C = \frac{E}{R}$ is of great importance, and is known as

Ohm's Law

Put into words the equation is :—

Current = Electro-Motive-Force ÷ by Resistance.

i.e., Ampères = Volts ÷ by Ohms.

It will be understood that if any two of these quantities are known, the third can be found by simple calculation. Thus :—What current will be obtained from a cell whose E.M.F. is 1·5 volts when the resistance of the total circuit is 3 Ohms ?

According to Ohm's Law, Current $= \frac{1{\cdot}5}{3} = {\cdot}5$

∴ the current is ·5 of an Ampère.

Three Ohms is the resistance of the *total* circuit, i.e., internal resistance and external resistance added together. Since there are two distinct parts of the circuit whose resistance must be reckoned, Ohm's Law is expressed better by the formula :—

$$C = \frac{E}{R + r}.$$

Where R = external resistance and

r = internal resistance of the cell.

Assuming that in the example quoted, the internal resistance is ·8 Ohm and the external resistances 2·2 Ohms, the calculation is

$$C = \frac{1{\cdot}5}{2{\cdot}2 + {\cdot}8} = \frac{1{\cdot}5}{3} = {\cdot}5.$$

If current strength and voltage are known, the total resistance can be calculated. We divide voltage by resistance to find current, so that we can find the total resistance by dividing voltage by current.

For example, the voltage is 1·6 and the current is ·4 Ampères, find the resistance of the complete circuit.

The calculation is $\frac{1{\cdot}6}{{\cdot}4} = 4.$

∴ the resistance of the complete circuit is 4 Ohms.

When current and total resistance are known, the E.M.F. can be calculated by multiplying the current by the resistance.

Thus, if the current is ·3 Ampère, and the total resistance is 5 Ohms, what is the E.M.F. of the apparatus supplying the current ?

Multiplying current by resistance we have

$$·3 \times 5 = 1{\cdot}5.$$

Therefore the E.M.F. is 1·5 volts.

L. M. P.

BOTANY.—IV

8. Change in Weight in Germination.—If the reader has understood the discussion in our previous lesson, he will realise that a seed must in general lose weight during germination. For while respiration goes on, there is no new source of food available. The growing embryo draws on its stored-up proteins and starch, which are transferred to the living parts, to be used in making new protoplasm, some of which is destroyed. This may be tested thus :—

DEMONSTRATION XII

Take twenty peas of approximately equal size, and divide them into two groups of ten each in such a way that the two groups are as nearly as possible of the same weight. Soak the peas of one group in water and leave them to germinate for a few days. Meanwhile, cut the others into small pieces, and heat them in a glass tube for some time on a water bath or in a slow oven, taking great care that the material is not charred. Find the weight of the residue, and you will have the *dry weight* of ten peas. The heat will have deprived the peas of whatever free water they contained. In the same way find the dry weight of the ten seedlings. This will be found to be less than the dry weight of the ten seeds before germination. Care must be taken to prevent charring, as that indicates the decomposition of starch or other substances in the seed, which would vitiate the experiment.

The loss of weight here indicated does not, of course, continue indefinitely. When the plant begins to develop green leaves, it is able to manufacture its own starch, as we shall see later on. After that the making side of metabolism predominates greatly over the destructive side, and the plant increases in size and weight. An experiment should be made with seedlings that have developed their leaves, in order to settle that point in the proper scientific manner.

It is interesting to note that germination will commence and continue for some little time without air being present. Carbon dioxide gas is given off, thus showing that the destructive metabolism is taking place. Whence comes then the oxygen required ? It can only be that the oxygen which exists in combination in all the substances of the seed is drawn upon. This is called *intramolecular respiration ;* and obviously it cannot go on for long without destroying either the protoplasm itself or the substances which make it.

DEMONSTRATION XIII

Introduce two well-soaked peas into the space above the mercury in a simple barometer. The peas will rise to the surface if they are pushed under the open end of the tube. In the course of two or three days the peas will be seen to be re-

luctantly germinating; and the mercury will have fallen in the tube. This is due to the production of carbon dioxide gas by intramolecular respiration. Introduce by means of a bent glass tube a drop of strong potash below the open end of the tube. This will rise in the tube and absorb the carbon dioxide gas, thus allowing the mercury to take its original height in the tube (Fig. 19).

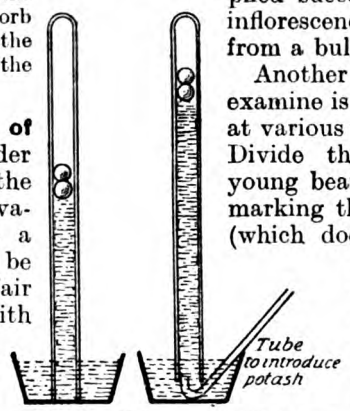


Fig. 19.—Demonstrating intramolecular respiration.

9. Rapidity and Amount of Growth.—The rate of growth under different conditions can be made the subject of a series of simple observations by the student. Suppose a number of beans or peas to be allowed to germinate, until a fair number of them are available with their radicles about an inch long. Dry the radicle of the seed to be experimented upon with blotting-paper, and make a fine mark on it with good Indian ink at a measured distance from the end of the radicle. Record the length of this measured piece day by day, when the seed is kept as far as possible under constant conditions. By comparison with other radicles on which equal lengths are measured, we can study the effects of withdrawal of water, absence of oxygen, darkness, heat, cold, etc., on the amount of growth, and obtain very instructive results.

The length of the plumule may be measured whole, from the level of the seed to the tip: it is interesting thus to make a definite comparison between the growth of a young root and that of a young shoot under similar circumstances.

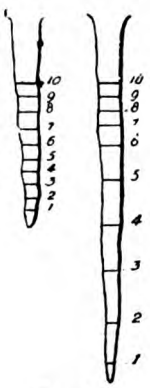


Fig. 20.—Growth in roots.

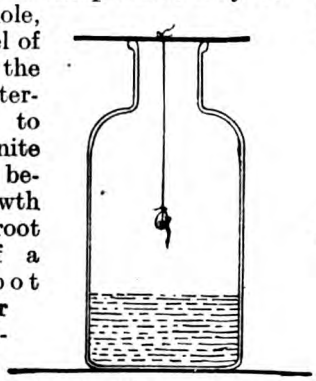


Fig. 21.—To examine the distribution of growth at various parts of a growing organ.

Another method of measuring the growth of any kind of shoot is to tie a very light cord on to the shoot just behind the tip, pass the cord over a light, smooth pulley fixed vertically above the plant, and keep it taut by a light weight. This weight must be the lightest possible, so as not to strain the growing shoot. If a metre scale be supported behind the weight (Fig. 22), we can measure the fall of the weight and thus the elongation of the shoot. This method is very suitable to strong shoots; it can be applied successfully to the developing inflorescence of a hyacinth, grown from a bulb in a vase.

Another interesting problem to examine is the distribution of growth at various parts of the growing organ. Divide the inch-long radicle of a young bean into ten equal divisions, marking them with good Indian ink (which does not run). Support the bean on a hooked pin in a jar containing water, but do not let the radicle touch the water (Fig. 21), so that the seedling is growing in damp air. Measure the distances between the successive marks after two days' growth. They will then be unequal, and it will be found that the greatest growth has been near the tip, though the space actually including the tip has not increased so much as the two immediately behind it. The spaces most removed from the tip have increased very little, if at all. Thus growth seems to be confined to a small region near the tip of the radicle, which we name the *growing-point* (Fig. 20).

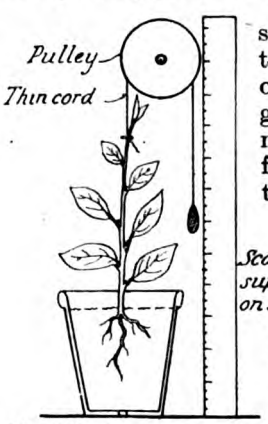


Fig. 22.—To measure the growth of a shoot.

We shall restrict the use of this term later on to that region in which new cells are forming, as distinct from the region immediately behind it, where increase of size only takes place without the production of new cells. The latter aspect of growth alone concerns us here.

Associated with growth are the movements which we have hitherto known as geotropic and heliotropic, the responses to gravitation and to light. If a bean is so placed that its radicle would emerge upwards,

the radicle will infallibly curve and grow vertically downwards. Now, the power to make this curve resides only in the actively growing region, as simple observation will show. Take a seed in which about 1½ inch of radicle is developed; arrange it with the radicle pointing upward, and note carefully how and where it curves. The developing plumule may be treated in the same way.

Geotropism at least is a phenomenon intimately connected with growth. If growth is stopped by cutting off about ¼ in. of the radicle or plumule, no curvature results, however the seed may be placed. The action of light is more complicated, but in its effect on developing seedlings its behaviour is, like that of gravitation, dependent upon the stimulus of growth.

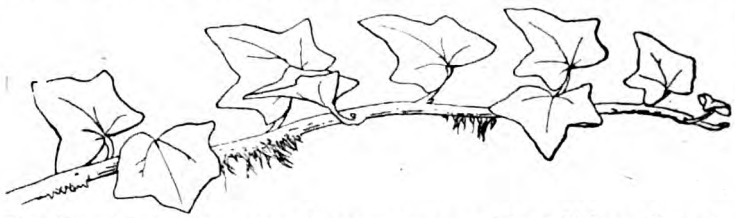


Fig. 23.—Adventitious roots, i.e. roots such as those which are formed from the stems of ivy and which bear the pads by which the ivy is fixed to its support.

10. The Root.—The radicle is the young root, and in the normal way it grows into the soil, fixing the plant there, through its profuse branching in all directions. The main axis of the root continues to grow vertically downwards; its first branches are more or less horizontal in direction; these branches in their turn branch vertically, and thus the soil is firmly gripped. The root-branches are formed in *acropetal succession*, i.e. the newest branches are those nearest the tip. Often the main root-axis is much stouter and stronger than its branches, forming what is known as a *tap-root*, as in the dandelion; sometimes, however, we have *fibrous* roots, as in the grasses. In these the root begins to branch immediately on, or even before, emergence from the seed; the main axis is suppressed, and the final effect is that of a bunch of stringy fibres.

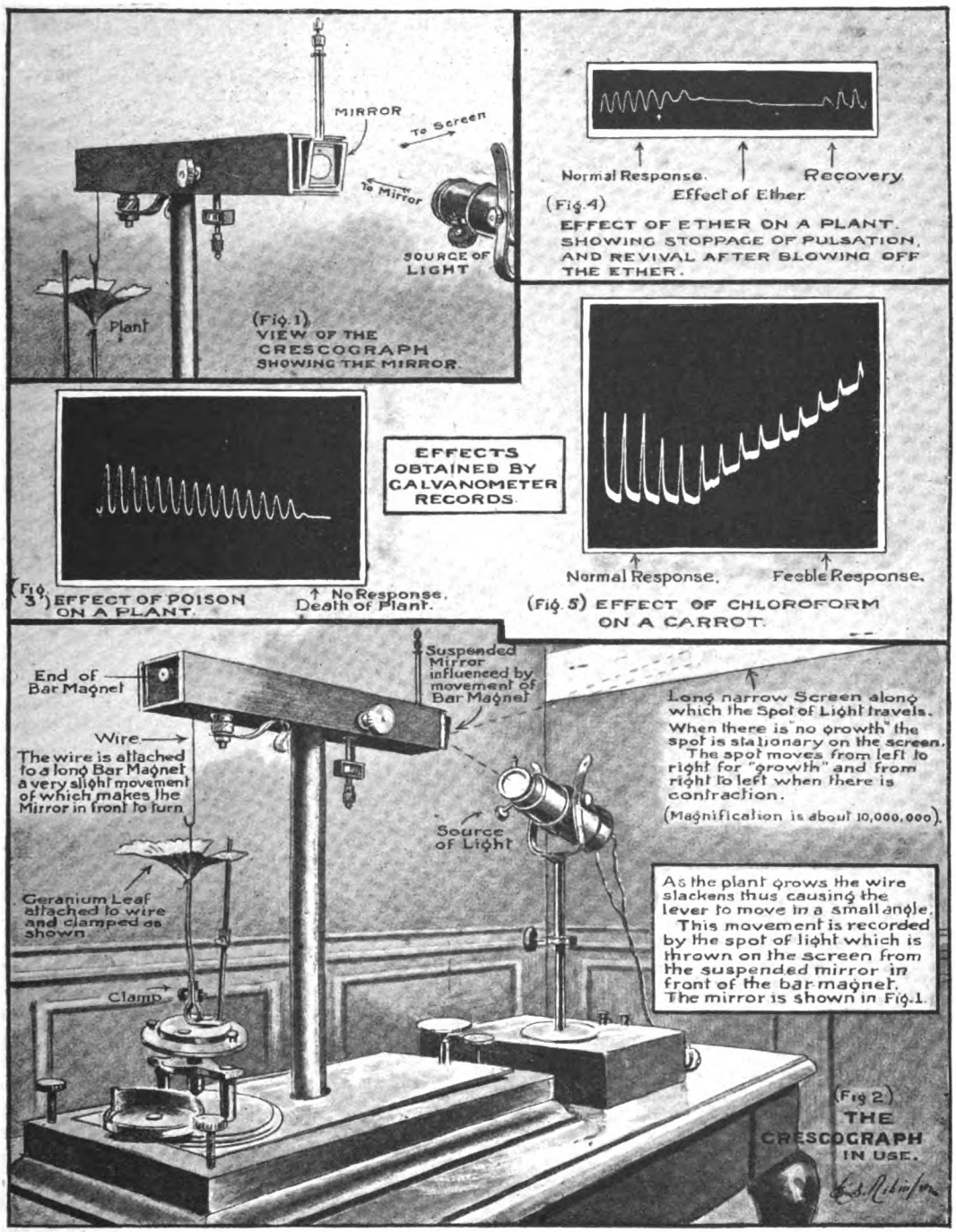
Roots arise in many instances from stems; they are then known as *adventitious* roots. Such roots are formed from the stems of ivy, and bear the pads by which the ivy is fixed to its support (Fig. 23). The bramble has creeping stems from which adventitious roots are produced where the stem strikes the ground. Many other plants have stems which creep either on or just beneath the ground. These give off adventitious roots at various points in their course. Many plants, too, can be propagated by *cuttings*. This is due to their ready formation of adventitious roots when they are put into the ground. In most cases the adventitious roots are tufty or fibrous.

Sometimes the root becomes very much enlarged with food-material. The turnip, carrot and parsnip are familiar examples. The turnip is a biennial: during its first year it produces more carbo-hydrate and protein than it needs; this is stored, and used for the production of the flowers and seeds in the second year. In the dahlia, certain orchids, and the lesser celandine (Fig. 24), the root consists of a bunch of tubers. These cases should be carefully examined, and the exact position of the buds in the axils of the leaves noted. If their growth be watched, it will be found that the new tubers arise as adventitious roots from the base of the stem. The use of the tubers during growth, and their gradual diminution in size as growth proceeds, can be well studied in the dahlia. The carbohydrate present in the dahlia tubers is not starch, but a soluble kind of starch called inuline.

If a seedling is allowed to develop in the soil for two or three days, and is then drawn out, the soil is found to adhere very closely to the young root—so closely that it is difficult to shake it all away. This is due to the presence of many very fine hairs on the root, especially at its young parts near the growing-point. These *root-hairs*, as will be shown in our next lesson, serve to bring the surface of the root into more intimate contact with the soil. They can be well seen, as a filmy down, on the radicles of seedlings developed in damp air without contact with water or soil. Their exact nature can only be made out with the microscope.

Fig. 24.—Roots of the lesser celandine.

A root gradually tapers to a fine conical point; but if the end of a root be attentively examined under a hand-lens, it will often be possible to make out the *root-cap*, a kind of protective lid for the growing-point. The



Drawn by W. B. Robinson.

THE PERCEPTIONS OF PLANTS

not only can be proved but can now be measured, thanks to a remarkably ingenious instrument invented by Sir Jagadis Chandra Bose, the Indian biologist. The essential part of his Magnetic Crescograph is a long magnetic lever. The smallest movement of the free end of this lever causes a movement, at the other end, of the needle with mirror attached. A beam of light is thrown on the mirror, and the reflected spot is shown on a screen so that all movement can be observed.

root-cap is composed of cast-off tissue which protects the delicate tissue beneath against the hard particles of the soil. In well-washed rootlets it appears more transparent than the root itself (Fig. 25).

An examination of a carrot gives us an idea of the internal structure of a root. The yellow centre is very well-defined from the red outer cylinder, which forms the *cortex*. As distinct from the cortex, the yellow centre is stringy; it is evidently made up of elements the strongest of which are lengthwise disposed. These longitudinal elements are the water-carrying tissue: they are known as *vessels*, and the central axis of the root may be spoken of as the *vascular cylinder*.

On the outside of this yellow vascular cylinder definite ridges can be seen, which give rise to the branch rootlets. This internal or *endogenous* origin of the branches distinguishes a root from a stem in which the branches rise exogenously. The distinction between the central cylinder and the cortex, which is so obvious in the carrot, is characteristic of all fully-grown roots in which there is no difference of colour to help us.

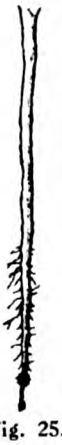


Fig. 25.—Root with root-hairs and root-cap.

11. Work of the Root.—The two main functions of the root are (1) to fix the plant in the soil; and (2) to absorb water

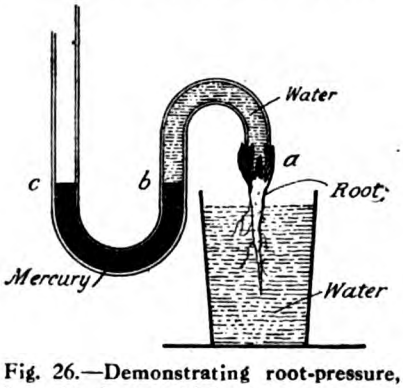


Fig. 26.—Demonstrating root-pressure, i.e. the force which causes water to rise in a root.

and dissolved substances from the soil. Upon the second of these, the proper nutrition of the plant depends.

DEMONSTRATION XIV

Grow a few mustard-seeds till their radicles are about ¾ in. long. Then arrange a few of them so that their radicles dip into water coloured pink by a few drops of red ink. After a few hours the roots will be stained with the colour, which can also be followed in streaks up the stem and into the cotyledons. Examination will show that the course the water takes is along the vascular tissue.

If any strong rapid-growing plant be cut, in the earlier stages of its growth, close down to the ground, the issue of water from the cut end of the root can often be observed, especially under a hand-lens. This phenomenon of "*bleeding*" is especially strong in young shoots of the vine or of clematis, but it may often be observed in sunflowers, dandelions, nettles, etc.—only, however, in spring time when growth and absorption are active. The fact that the water *rises* in the root shows the existence of what is called *root-pressure*, a force causing it to do so. The existence of this pressure may be shown and measured as follows:—

DEMONSTRATION XV

Dig out the entire root of a dandelion, and fasten it firmly by means of indiarubber tubing into a glass tube bent as shown in Fig. 26. Fill the tube completely with water and mercury, as shown; taking care that no air remains between *a* and *b*. Arrange the tube so that the root dips into a vessel of water. If the root remains active, the mercury will be forced along from *b*, and the alteration of the difference in level between *b* and *c* will measure the root-pressure.

When we remember that water is raised in many large trees to a height of sixty feet or more, we are able to realise the full power of this force. E. W. E.

ZOOLOGY.—XIX

THE Divers, of the family *Colymbidæ*, are represented in Britain by three species of which the Great Northern Diver or Ember Goose is easily the best known.

This bird breeds in Iceland and in the northerly islands of the British Isles and rarely comes south except in the summer, when he frequents the sea more than the land. Sometimes attaining a length of three feet, with his black and purple head, his black back and white underparts, the Ember Goose presents a very handsome appearance. The legs, as is the case with all the divers, are set far back on the body. The Ember Goose, unlike the Guillemot, reserves his wings strictly for flying, and makes no use of them under the water. The nest of this bird is sometimes described as being of the roughest possible construction, but it is open to doubt if, as a matter of fact, it ever troubles to make one.

The Black-Throated Diver and the Red-Throated Diver, sometimes called the "Rain Goose," are similar in their habits to the Great Northern Diver.

The Razor-Bill, of the family *Alcidæ*, is a well-known British bird, which in appearance closely resembles the Puffin. The Puffin, a twelve-inch study in black and white, is common to many parts of Europe, and may often be found round the British coast, nesting in a rabbit-burrow or similar hole.

The Guillemot is a larger bird than the Razor-Bill and is more frequently seen in Britain. In Iceland, the Orkneys, and other northern lands in which these birds nest, they form large colonies from which great numbers are captured for their feathers. Mr. Kearton records what must surely be a unique method of capture practised in the Hebrides. "About three weeks after the birds have returned to their breeding quarters on the rocks they are suddenly driven away from a number of ledges late one evening, and long before dawn the following morning a man is lowered to each. Here he sits, motionless as a statue, and at the first suggestion of daybreak the birds stream up from the sea and alight upon him, thinking he is a rock, and are promptly secured and killed." Mr. Kearton adds that as many as a hundred birds are thus secured in an hour, but that as soon as day breaks and the birds can see the fowler the sport is at an end.

The Grebes, of the family *Podicipedidæ*, are diving birds which are seen more frequently over fresh water than on the sea. Though they possess the long neck and pointed bill of the diving bird proper, they can readily be distinguished by the absence of tail feathers.

The Great Crested Grebe, a British bird with a wide range over the old world, is valued for the white breast feathers. The Dabchick or Little Grebe, the smallest and most common of the British species, is a shy bird, and for that reason somewhat difficult to find. Its powers of diving, which are considerable, are brought into action on the slightest alarm.

The Penguins, of the order *Impennes*, have been made world-famous by photographs taken in their southern haunts by Antarctic explorers. An extremely archaic group, the Penguins have lost the power of flight, though their truly wonderful powers as swimmers and divers afford in most cases adequate compensation. For the most part the Penguin lives in the water where, as truly at home as a swallow in the air, he is well qualified to fend for himself. During the breeding season, however, the Penguin betakes himself to one or other of the desolate coasts frequented by his race and here, as a member of a colony whose

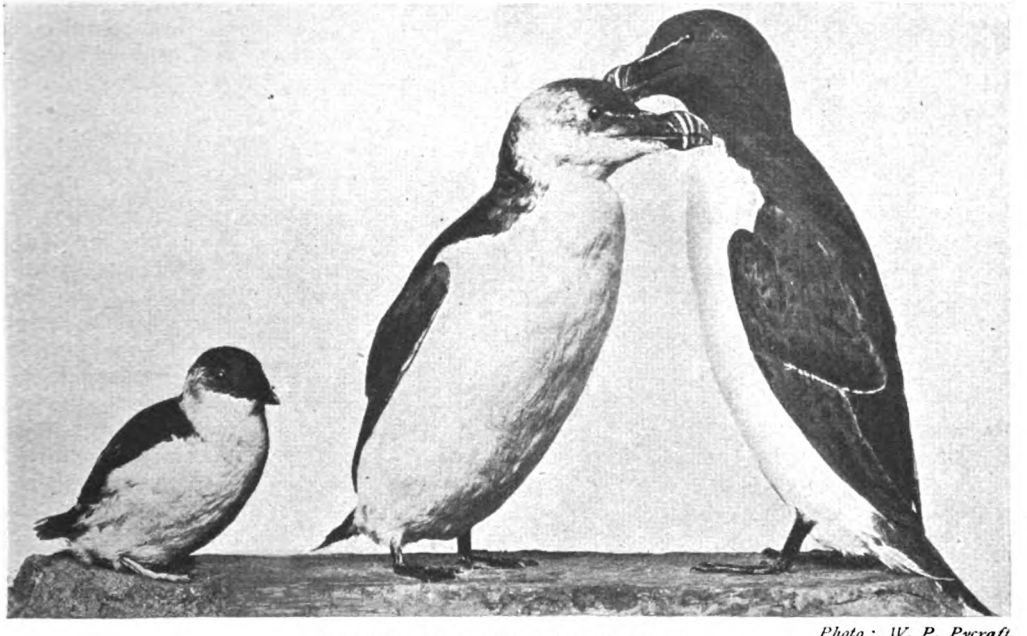


Photo: W. P. Pycraft.

LITTLE AUK AND RAZOR BILLS.

The latter belong to the Alcidæ family and are well-known British birds, closely resembling the Puffin in appearance.

manners absurdly burlesque human intercourse. he mates and rears his young.

On foot the Penguin moves with difficulty, so much so, indeed, that in time of stress he brings his wings into action and proceeds upon "all fours." But when unhurried his slow gait, his thoughtful manner and his erect form give him an appearance all his own. The infrequency with which these birds of the Antarctic encounter men has made them peculiarly fearless.

Of the sixteen or more different species the best known are the Emperor Penguins, the largest of the order, inhabiting the Antarctic seas, the King Penguins, found in Kerguelen Land, the Falklands and other southern islands, and the Cape Penguins, ranging from the west coast of South America to the Cape of Good Hope.

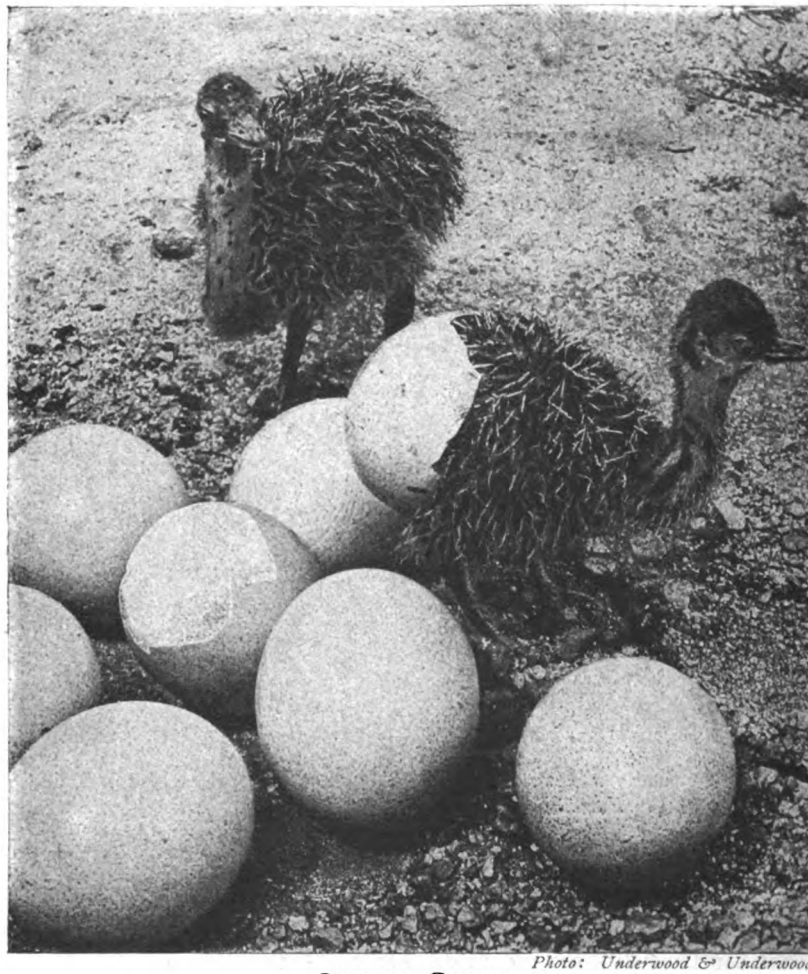


Photo: Underwood & Underwood.

OSTRICH CHICKS

when hatched support themselves for a time by feeding upon eggs which the mother bird lays, for this specific purpose, and cracks, around the nest.

Under the heading "Flightless Birds," of the order *Ratitæ*, we include the largest and in some respects the most defenceless members of their race. Unlike the flying birds, the Ostrich, the Rhea, the Emu and their fellows lack the supporting keel which strengthens the breastbone when strong wing muscles are needed. For the wings of the flightless birds are almost negligible factors, mere relics of a power lost from disuse, discarded for a life of lazy comfort in bygone days of safe prosperity. The legs of these birds, however, are abnormally developed. Of considerable length and strength they permit of great speed, though speed, indeed, is but a poor weapon with which to meet man within his own sphere.

The Ostrich is the largest of all existing birds, and is now confined to Africa, Arabia and Syria, though fossil remains indicate that it once had a much wider range in Asia. From six to eight feet in height, this bird is capable of covering twenty-five feet or so at a stride, and when running before the wind with wings outstretched, it can easily outstrip a fleet horse.

When living in its natural, wild state the Ostrich associates with his fellows in great flocks. He is a vegetable feeder but eats grit, it is said, to assist digestion. He mates with five or more hen birds, and nests on the ground. The young birds when hatched support themselves for a time by feeding upon unhatched eggs which the hen bird has thoughtfully laid and cracked round the nest. Ostrich hunting, though afford-

ing a certain amount of excitement, is no longer indulged in for financial reasons, since the market is supplied with plumes by the ostrich farms of South Africa.

The Rhea, sometimes called the South American Ostrich, is a smaller bird than his South African relative, and ranges from Brazil to Patagonia. Compared with those of the Ostrich proper, the plumes of the Rhea are of slight value. Though this bird is a swift runner, his foot differs from that of the Ostrich in that the Rhea has three toes whilst the Ostrich has only two. On occasion the Rhea can prove himself a strong swimmer. The writer well remembers an exciting half-hour during which half a dozen of these birds were captured from boats upon the river Paraguay.

Australian Birds

The Emu, an Australian bird, resembles the Ostrich in many of its habits. It stands about six feet in height, frequents open and sandy country, and is dark grey in colour. With the steady opening up of Australia, this bird has diminished in numbers, and in a wild state will soon be extinct. The Cassowary is a smaller bird than the Emu, which, however, it resembles in that it has three toes to the foot. It is confined to Australia New Guinea and adjacent islands. Like the Rhea, or South American Ostrich, the Cassowaryis an accomplished swimmer.

The Kiwis, natives of New Zealand, are small flightless birds which with increasing population are doomed to extinction. The largest of the species, Shaws Kiwis, now shows but scant evidence of the flying powers which at one time it probably possessed. The wings are almost atrophied, and the entire build of this bird is little in harmony with any other than a terrestrial life.

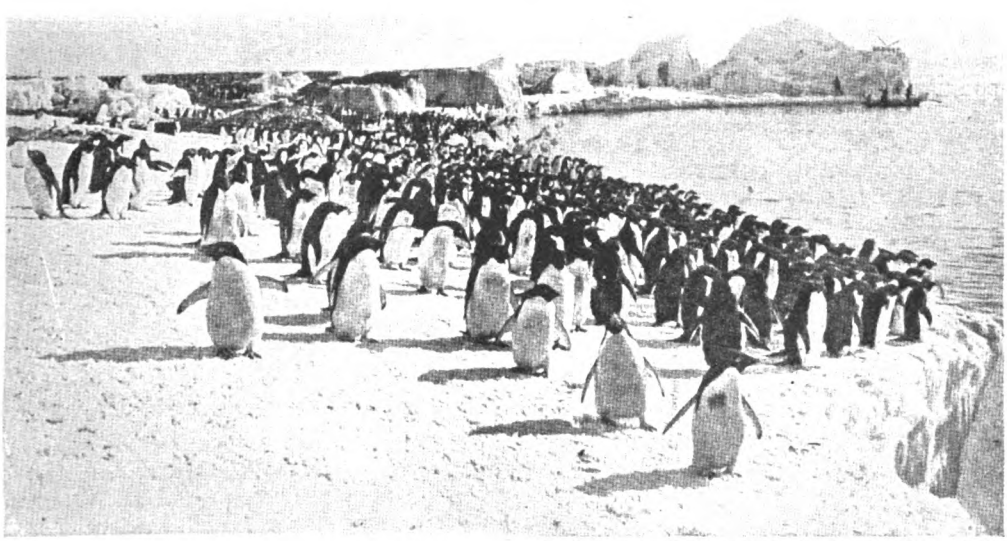
Habits of the Kiwi

Already the Kiwi has learnt the dangers that menace it, and it is now rarely seen abroad except after nightfall, when it seeks for worms in stealthy silence.

It hides by day in holes in the ground or amongst rocks, when it rolls itself up as a hedgehog might do. Swift of foot it advances in great strides with outstretched neck. When standing in an erect position it partly supports itself on its long beak which is used as a third leg.

The bird usually lays two eggs, which are rather large in proportion to its size. The biggest specimen of the Kiwi family hardly exceeds two feet in height, and in size it may be compared with a large domestic fowl.

A. B.



From "Antarctic Penguins" (Dr. G. Murray Levick, R.N.), by courtesy of the publishers, Messrs. Heinemann.

ANTARCTIC PENGUINS

have lost the power of flight, though as swimmers and divers they have truly wonderful strength; their habits and manners in many respects are an absurd burlesque of those of human beings.

Continued from page 287.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A.[Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—XXII

WE must now turn our attention to syntax, that branch of grammar which teaches how the various inflected forms of words are combined into sentences. Already you have gained some knowledge of this, especially if you have carefully studied the Latin sentences given you in the exercises.

Syntax

A **sentence** is a series of words constituting an affirmation, question, command, or request. It may be either simple or complex.

A simple sentence contains only one independent affirmation or question, and has only one finite verb, as **puer currit**, *the boy runs;* **vidistine** *? hast thou seen?* **vide**, *behold;* **sis felix**, *mayst thou be fortunate.* Several such simple sentences connected together by co-ordinate conjunctions, without subordination of one to another, as **puer abiit atque rediit**, *the boy went away and returned*, are called a compound sentence.

A complex sentence contains one principal sentence and one or more subordinate sentences (often called " dependent clauses ") each of which has its own finite verb but by itself does not express a complete meaning. Thus in the complex sentence **Rosa, quae floret, bene olet**, *the rose, which flourishes, smells sweetly*, the principal sentence is **rosa bene olet**, *the rose smells sweetly*, and **quae floret**, *which flourishes*, is the dependent clause. Again, in **si tibi mens avida est belli, praebebimus hostem**, *if your mind is set upon war, we will provide an enemy*, the principal sentence is **praebebimus hostem**, *we will provide an enemy*, and the dependent clause is **si tibi mens avidi est belli**, *if your mind is set upon war.*

These dependent clauses may be of an adjectival, adverbial, or substantival nature. Thus the clause **quae floret**, *which flourishes*, describes the kind of rose in question, and is of the nature of an adjective qualifying the noun **rosa**. The clause **si tibi mens avida est belli**, *if your mind is set upon war*, expresses the condition under which the act is predicated, viz. **praebebimus hostem**, *we will provide an enemy.* In other words, it modifies the verb **praebebimus (hostem)** precisely as an adverb would, and is accordingly an adverbial clause. But in the sentence **placuit ei ut ad Ariovistum legatos mitteret**, *he decided to send ambassadors to Ariovistus*, the subordinate clause **ut ad Ariovistum legatos mitteret**, *that he would send ambassadors to Ariovistus*, is of the nature of a substantive, denoting what it was that Cæsar decided, and is therefore a substantival clause. In analysis, as we shall see presently, it is the subject of the principal sentence, forming the nominative to the verb **placuit**.

Sentences may also be classified according to their meaning, or the nature of the connection between the two ideas of which the thought expressed in any sentence consists. Thus we get four types of sentences :—

1. Affirmations or direct statements, as **Cicero loquitur**, *Cicero speaks.*

2. Questions or interrogative sentences, as **quis loquitur**, *who speaks ?*

3. Imperative sentences, or commands, prohibitions, or requests, as **loquere, puer**, *speak, boy;* **Noli me tangere**, *do not touch me.*

4. Optative sentences or wishes, as **puer sit felix,** *may the boy be happy.*

The last two are clearly allied, the expression of a wish having the character of either a direct request or of an affirmation in a complex sentence, as in **spero ut veniat**, *I hope that he will come*, where the thing wished is placed in the dependent clause. Exclamations, which are abbreviated sentences, fall into various classes

according to the nature of the verb, which is usually the part missing.

The simplest sentence, we see, must express one complete thought. In English this requires at least two words, except in the case of a command or request, which may be expressed by one word, a verb, the *you* or other personal pronoun being understood. In Latin, as many examples have shown us, a simple sentence is often contained in one word; thus, in **loquor**, *I speak*, or **currit**, *he runs*, the personal ending is sufficient to indicate the subject without the use of a separate pronoun.

The thought expressed in any sentence contains at least two ideas, and states some connection between them. Thus, **loquor**, *I speak*, contains the ideas *I* and *speak*, or *I am speaking*. In this latter shape we see differentiated the idea *I*, called the subject, the idea, *speaking*, called the predicate, and the word *am* (often called the copula or connecting link) expressing the nature of the connection between these two ideas. This copula actually appears comparatively seldom in Latin sentences, and it will be more convenient to regard the sentence as normally consisting merely of the subject, or that of which something is affirmed, and the predicate, or that which is affirmed of it, the copula as a separate entity being ignored.

Nevertheless, when we analyse a sentence as the expression of a thought, remember that it can always be cast into such a form as shows these three constituents, the subject, the predicate, and the copula, the last-named being usually some form of the verb **esse**, *to be*, as in **rex est fortis**, *the king is brave*, **Fabius erat consul**, *Fabius was consul*, **loquor**, *I am speaking*, **vidistine**? *dost thou see?* or *art thou seeing?* where the words **est**, **erat**, or the English *am*, *art*, represent the connection between the ideas expressed in the subject and the predicate.

The simple sentence thus contains a subject, expressed by means of a substantive (noun or pronoun) or a word indicating a substantive, or else unexpressed, and a predicate, which must be a finite verb or else a substantive or adjective with the copula. But the subject or the predicate or both may be added to in various ways, thus becoming complex, and yet the sentence remain simple. Such additions are called complements.

Complements may consist of attributes added to substantives to complete their sense, of substantives in oblique cases completing the idea expressed by the verb, or adjectives or nouns referring to the subject or object and completing the predication, or of adverbs or adverbial phrases modifying verbs or adjectives.

(1) Attributes or qualifying words may be added to the subject to make its meaning more definite. Such attributes may take the form of

(*a*) An adjective, as in—

bonus vir loquitur, *the good man speaks.*

(*b*) A noun in apposition, as in—

Julius consul venit, *Julius the consul came.*

(*c*) A noun in the genitive case, as in—

vis animi, *force of mind.*

(*d*) A relative sentence, as in—

vir, quem vides, rex est, *the man, whom you see, is king.*

In the last illustration the sentence is not, however, simple but complex.

(2) The predicate may be completed in various ways.

(*a*) Transitive verbs, as we saw at a very early stage, require an accusative case after them expressing the result of the action of the verb. This is called the direct object of the verb, thus—

magister puerum laudat. *the master praises the boy.*

(*b*) A substantive in an oblique case may be required to complete the idea expressed by the verb. This is called the indirect object, as in—

pater libros puero dat, *the father gave books to the boy.*

(*c*) A verb by itself may express an incomplete idea and require an adjective or noun to complete its meaning. This is called the secondary predicate, as in—

Plato videbatur sapiens, *Plato seemed to be wise.*

Platonem sapientem vocabant, *they used to call Plato wise.*

(*d*) Adverbs or adverbial phrases may be added to verbs and adjectives to express limitations of time, place, manner, etc., as in—

paulum hostium impetus tardatus est, *the attack of the enemy was slightly retarded.*

The laws governing the inflexions of words in Latin are very strict, and unless the student masters the rules of agreement or concord he will never be on safe ground, and will continually fall into serious errors.

Agreement of concord is conformity in the inflexions of words that stand to each other in certain relations. It may be simple or compound, simple when one word agrees in inflexion with another word, compound when a word agrees with several other words.

The rules of agreement are summed up in the three concords, which may be briefly stated and left until we are able later to consider them in detail. The student will in all probability be familiar already in practice with the principles thus formulated. They are as follows :—

Concord I.—A finite verb agrees with its subject in number and in person.

Concord II.—An adjective, participle, or adjectival pronoun, used either as an attribute or a predicate, agrees with its substantive in gender, number, and case.

Concord III.—A relative agrees with its antecedent in gender, number, and person, and also in case if they are in the same clause.

Exercise 21

Translate into English :—

1. Quae vis insit in his paucis verbis, si attendes, intelliges. 2. Per speciem alienae fungendae vicis opes suas firmavit. 3. Murum urbi cocto latere circumdedit, arenae vice bitumine interstrato. 4. Defatigatis in vicem integri succedunt. 5. A bove maiori discit arare minor. 6. Non ignara mali miseris succurrere disco. 7. Apparent rari nantes in gurgite vasto. 8. Auxilia humilia firma consensus facit. 9. Dimidium facti qui coepit habet. 10. Aequam memento rebus in arduis servare mentem.

Translate into Latin :—

1. There was never a (no) great genius without some mixture of madness. 2. Ignorance of the law excuses no one. 3. Add little to little and there will be a great heap. 4. Fools' names are stuck on (cling to) housewalls. 5. Let not the cobbler have views (judge) beyond his last. 6. They condemn what they do not understand. 7. Control your feelings, which command unless they obey. 8. Indulgence is granted to (a case of) necessity. 9. Apollo hears (when) called upon. 10. Let us seek honourable things from (our) friends.

Key to Exercise 20

1. It is incredible how much I write by day—nay, even in the nights. 2. This day both restored their spirits to the Romans and disheartened Perseus. 3. And yet I do not hate Aeneas, no matter how evil are his designs. 4. What exile from his country flees also himself? 5. To return worthy thanks is not in our power. 6. It is not a fault in him who is compelled to obey.

1. Omni ope atque opera nitar. 2. Dabit deus his quoque finem. 3. Me iam sanguis viresque deficiunt. 4. Quidquid non licet, nefas putare debemus. 5. Magna copia latronum in ea regione est. 6. Rerum copia verborum copiam gignit.

E. A. B.

FRENCH.—XXII

Irregular Verbs of the second conjugation may be grouped, as we saw on p. 279, in three classes. Some have already been dealt with ; others remain.

CLASS I (*Continued*)

MENTIR, *to tell falsehoods*

Mentir, mentant, menti, je mens, je mentis, conjugated like DORMIR.

OFFRIR, *to offer*

Offrir, offrant, offert, j'offre, j'offris.

IND. PRES.	IMPERF.
j'offre	j'offrais
nous offrons	nous offrions
etc.	etc.
PAST DEF.	FUT.
j'offris	j'offrirai
nous offrîmes	nous offrirons
etc.	etc.
COND. PRES.	IMPER.
j'offrirais	offre
nous offririons	offrons
etc.	offrez
SUBJ. PRES.	IMPERF.
que j'offre	que j'offrisse
que nous offrions	que nous offrissions
etc.	etc.

OUÏR, *to hear*

ouïr, ouï.

PAST DEF.	SUBJ. IMPERF.
j'ouïs	que j'ouïsse
nous ouïmes	que nous ouïssions
etc.	etc.

The other parts of this verb are not in use.

OUVRIR, *to open*

Ouvrir, ouvrant, ouvert, j'ouvre, j'ouvris, conjugated like COUVRIR.

PARTIR, *to leave, to set out*

Partir, partant, parti, je pars, je partis, conjugated like DORMIR.

SENTIR, *to feel*

Sentir, sentant, senti, je sens, je sentis, conjugated like DORMIR.

SERVIR, *to serve*

Servir, servant, servi, je sers, je servis, conjugated like DORMIR.

SORTIR, *to go out*

Sortir, sortant, sorti, je sors, je sortis, conjugated like DORMIR.

SOUFFRIR, *to suffer*

Souffrir, souffrant, souffert, je souffre, je souffris, conjugated like COUVRIR.

TRESSAILLIR, *to start, to shudder*

Tressaillir, tressaillant, tressailli, je tressaille, je tressaillis.

IND. PRES.	IMPERF.
je tressaille	je tressaillais
nous tressaillons	nous tressaillions
etc.	etc.
PAST DEF.	FUT.
je tressaillis	je tressaillirai
nous tressaillîmes	nous tressaillirons
etc.	etc.
COND. PRES.	IMPER.
je tressaillirais	tressaille
nous tressaillirions	tressaillons
etc.	tressaillez
SUBJ. PRES.	IMPERF.
que je tressaille	que je tressaillisse
que nous tressaillions	que nous tressaillissions
etc.	etc.

VÊTIR, *to clothe*

Vêtir, vêtant, vêtu, je vêts, je vêtis.

IND. PRES.	IMPERF.
je vêts	je vêtais
il vêt	nous vêtions
nous vêtons	etc.
etc.	
PAST DEF.	FUT.
je vêtis	je vêtirai
nous vêtîmes	nous vêtirons
etc.	etc.
COND. PRES.	IMPER.
je vêtirais	vêts
nous vêtirions	vêtons
etc.	vêtez
SUBJ. PRES.	SUBJ. IMPERF.
que vête	que je vêtisse
que nous vêtions	que nous vêtissions
etc.	etc.

Class II

COURIR, *to run*

Courir, courant, couru, je cours, je courus.

IND. PRES.	IMPERF.
je cours	je courais
il court	nous courions
nous courons	etc.
etc.	
PAST DEF.	FUT.
je courus	je courrai
nous courûmes	nous courrons
etc.	etc.
COND. PRES.	IMPER.
je courrais	cours
nous courrions	courons
	courez
SUBJ. PRES.	IMPERF.
que je coure	que je courusse
qu'il coure	que nous courussions
que nous courions	etc.
etc.	

MOURIR, *to die*

Mourir, mourant, mort, je meurs, je mourus.

IND. PRES.	IMPERF.
je meurs	je mourais
il meurt	nous mourions
nous mourons	etc.
etc.	
PAST DEF.	FUT.
je mourus	je mourrai
nous mourûmes	nous mourrons
etc.	etc.
COND. PRES.	IMPER.
je mourrais	meurs
nous mourrons	mourons
etc.	mourez
SUBJ. PRES.	IMPERF.
que je meure	que je mourusse
que nous mourions	que nous mourussions
qu'ils meurent	etc.
etc.	

Class III

TENIR, *to hold*

Tenir, tenant, tenu, je tiens, je tins.

IND. PRES.	IMPERF.
je tiens	je tenais
il tient	nous tenions
nous tenons	etc.
ils tiennent	
etc.	
PAST DEF.	FUT.
je tins	je tiendrai
il tint	nous tiendrons
nous tînmes	etc.
ils tinrent	
etc.	
COND. PRES.	IMPER.
je tiendrais	tiens
nous tiendrions	tenons
etc.	tenez
SUBJ. PRES.	IMPERF.
que je tienne	que je tinsse
que nous tenions	qu'il tînt
qu'ils tiennent	que nous tinssions
etc.	etc.

VENIR, *to come*

Venir, venant, venu, je viens, je vins, conjugated like TENIR.

Miscellaneous Idioms

S'en aller gives the sense *to go away, to leave*. It is conjugated in the present indicative as follows :—

je m'en vais	nous nous en allons
tu t'en vas	vous vous en allez
il s'en va	ils s'en vont

and interrogatively as follows :—

est-ce que je m'en vais ?	nous en allons-nous ?
t'en vas-tu ?	vous en allez-vous ?
s'en va-t-il ?	s'en vont-ils ?

In the compound tenses the pronoun **en** comes between the other pronouns and the auxiliary, thus—

je m'en suis allé	nous nous en sommes allés
tu t'en es allé	vous vous en êtes allés
il s'en est allé	ils s'en sont allés

Aller, *to go*, is used after the names of garments, etc. in the sense *to fit, to sit* (well or ill), as in :—

Mon habit va bien, *My coat sits or fits well.*

Essayer, *to try*, is used in the sense *to try on*, thus—

J'ai essayé mon gilet, il me va bien, *I have tried on my waistcoat, it fits me well.*

Être, *to be*, is used in the sense of *belonging*, as in—

À qui est cette maison ? *Whose house is that ?*
Elle est à mon cousin, *It is my cousin's.*

Se Fâcher, *to be angry*, takes the preposition CONTRE or DE before its indirect object, thus—

Il se fâche contre lui, *He is angry with him.*
Vous vous fâchez d'un rien, *You get angry at nothing.*

Se Réjouir, *to delight*, takes the preposition DE, thus—

Je me réjouis de votre bonheur. *I rejoice at your happiness.*

Se Plaire, *to be pleased, to take pleasure*, takes the preposition **à**, thus :—

Je me plais à la campagne. *I like to be in the country.*
Je me plais à étudier, à lire. *I delight in studying, in reading.*

Se dépêcher, se hâter, *to make haste*, take the preposition DE before an infinitive, as in—

Dépêches-vous de finir vos leçons. *Make haste to finish your lessons.*
Hâtons-nous aujourd'hui de jouir de la vie. *Let us hasten to-day to enjoy life.*

VOCABULARY

apporter, *to bring.*
l'après-midi (m.), *the afternoon.*
le beau-frère, *the brother-in-law.*
la botte, *the boot.*
casser, *to break.*
une centaine, *a hundred.*
le couteau, *the knife.*
donc, *then.*
le marché, *the market.*
rester, *to remain.*
serrer, *to squeeze, pinch.*
le succès, *success.*
valoir grande chose, *to be worth much.*
vite, *quickly.*

Exercise 41

1. Votre parent écrit assez bien et assez vite. 2. Vos bottes ne vont-elles pas bien ? 3. Elles ne me vont pas bien, elles me serrent trop. 4. Le prêtre s'en est-il allé ? 5. À quelle heure les compagnes de votre sœur s'en sont-elles allées ? 6. L'habit que vous tenez est-il à vous ou à votre frère ? Il lui va fort bien, et il lui sied bien. 7. Nous nous en sommes allées trop tard. 8. Je l'ai essayé, mais il ne me va pas bien. 9. Les livres de qui avez-vous apportés ? 10. J'ai apporté ceux de mon frère. 11. Ils ne sont ni à moi ni à vous. 12. De quoi vous réjouissez-vous ? 13. Pourquoi vous dépêchez-vous ? 14. Il se plait à jouer, il n'étudie jamais. 15. Vous plaisez-vous chez vos parents ? 16. Nous ne nous y plaisons pas. 17. Cet homme se fâche-t-il contre le commis ? 18. Se fâche-t-il bien souvent ? 19. Dépêchez-vous, il est déjà midi. 20. N'avez-vous pas tort de vous en aller si tôt ?

Exercise 42

1. I left at nine o'clock. 2. Does that dress fit you well ? 3. It does not fit me well. 4. Does that coat suit you well ? 5. Do those books belong to you or to me ? 6. To whom do they belong, then ? 7. He has not gone yet. 8. They went away towards six in the afternoon. 9. It belongs neither to him nor to me, it is my brother-in-law's. 10. Where did he have it made ? 11. They belong to me. 12. Our house is not good for much. 13. That cloth is good for nothing. 14. It is not worth much : it does not go well. 15. That person is worth a hundred thousand francs. 16. That house is worth five thousand francs. 17. Is not this knife worth more than yours ? 18. Is it not better to stay here than to go to market ? 19. It is not worth much ; it is broken. 20. We are delighted with your success.

Key to Exercise 38

1. Que venez-vous de faire ? 2. Votre frère va-t-il trouver son ami ? 3. Il va le trouver tous les jours. 4. Allez-vous chez cette dame lundi ? 5. J'ai l'intention d'y aller mardi. 6. Il va à l'église le dimanche. 7. Qu'allez-vous faire ? 8. Je vais apprendre mes leçons. 9. Je ne vais écrire à personne. 10. N'avez-vous pas l'intention de venir me trouver demain ? 11. Votre compagne va-t-elle à l'église tous les dimanches ? 12. Le samedi je reste chez nous, et le dimanche je vais à l'église. 13. Je m'amuse à lire l'allemand. 14. Vous ennuyez-vous souvent à la campagne ? 15. Reçoit-on des nouvelles de monsieur D ? 16. On n'entend pas parler de lui. 17. Ne vous trompez-vous pas quelquefois ? 18. Tout le monde se trompe quelquefois. 19. Je m'ennuie quand je n'ai rien à faire. 20. Je ne m'en sers pas, il ne coupe pas.

Key to Exercise 39

1. I shall go to church next Sunday. 2. We hate wicked people. 3. Any one who saw me would think I was going to an assignation or to get money. 4. I must certainly tell you what I think and feel. 5. Perhaps I am mistaken. 6. When I meet her, I shall recognise her. 7. You write correctly enough. 8. That child is attentive enough. 9. Has it been necessary to work very hard in order to finish the work in time ? 10. When ought one to write to our friend ? 11. Has the milliner everything necessary ? 12. Must I go to my father ? 13. May he be blessed for what he has done. 14. He gains more strength every day. 15. I shall leave for England to-morrow. 16. I have heard it said. 17. Do not take pleasure in the misfortunes of others. 18. Do they provide you with clothes when you want them ? 19. We are told that it is to take place this afternoon. 20. I wish to send it to you if you are willing to read it.

E. A. B.

GERMAN.—XIX

Verbs compounded with Prefixes.—There is a very large number of verbs in German compounded with separable and inseparable prefixes, and these can almost be formed at will. These prefixes are for the most part either adverbs or prepositions, but a few of the inseparable prefixes no longer exist as separate words, but only in compounds.

The following simple prefixes are used to form inseparable compounds: be, ent (emp), er, ge, ver, zer. They always remain in close connection with the verbal stem, forming one word, and consequently, when the Infinitive with zu is used, the zu precedes the Infinitive as a separate word.

Further, the Past Participle is formed without ge, which itself is an inseparable prefix. No part of a verb can be formed with two inseparable prefixes. Thus, *to recommend* is zu empfehlen, and *recommended* is empfohlen (Past Part.).

The student is reminded once more that verbs compounded with inseparable prefixes always take the accent on the verbal stem, and never on the prefix.

We shall now give examples of verbs compounded with inseparable prefixes, illustrating the principal meanings and uses of these prefixes. They are used to form derivative verbs not only from other verbs but also from other parts of speech.

Be.—This is derived from the preposition bei. When attached to an intransitive verb it makes it transitive. Thus, sprechen, *to speak*, besprechen, *to discuss*; singen, *to sing*, besingen, *to sing about*; kämpfen, *to fight* (intrans.), bekämpfen, *to combat*. Compare the English wail and bewail. When attached to a transitive verb it frequently changes the direction of the verbal action; the accusative of the simple verb usually is turned into a dative governed by the preposition mit, and what was only remotely connected with the simple verb becomes the direct object. Thus: Wasser auf den Boden sprengen, *to sprinkle water on the ground*; den Boden mit Wasser besprengen, *to besprinkle the ground with water*; (ein Bild) malen, *to paint* (a picture), (eine Wand mit Farbe) bemalen, *to cover* (a wall) *with paint*.

Sometimes it scarcely alters the meaning of the simple transitive verb, except that it intensifies it slightly. Thus: decken and bedecken, *to cover*; harren and beharren, *to wait, persist*.

Some of its compounds are only used reflexively, as sich betragen, *to behave oneself*; sich begnügen, *to content oneself*.

Compounded with adjectives it forms verbs meaning "to make" (good, rich, etc.). Thus: eng, *narrow*, beengen, *to make narrow*, ruhig, *quiet*, beruhigen, *to calm*; reich, *rich*, bereichern (from the comparative reicher), *to enrich*. Compounded with nouns it has the meaning to furnish with. Thus: Gnade, *grace, mercy*, begnaden, *to furnish with mercy*, i.e. to pardon; Grenze, *boundary, limit*, begrenzen, *to supply with a boundary*, to *limit*.

Ent.—In three verbs beginning with f, it has become by assimilation emp, i.e. empfangen, *to receive*, empfehlen, *to recommend*, empfinden, *to feel*. It is derived from an adverb the original meaning of which was "against" or "towards," and its earlier form was ant, still preserved in antworten, *to answer*. This meaning is found in gelten, *to be worth*, entgelten, *to requite*; sprechen, *to speak*, entsprechen, *to correspond* (to).

Of other meanings which it has developed the following are the most important: It is equivalent to "up" in stehen, *to stand* entstehen, *to rise up, arise*; springen, *to spring*, entspringen, *to spring up*. It denotes "beginning" in brennen, *to burn*, entbrennen, *to take fire*; blühen, *to flower*, entblühen, *to break into bloom*. It denotes "separation and removal" in kommen, *to come*, entkommen, *to escape*; ziehen, *to draw*, entziehen, *to draw away, to deprive*; sagen, *to say*, entsagen, *to remove by saying, to renounce*.

A kindred meaning to the last is that of "negation" or "reversal." Thus, decken, *to cover*, entdecken, *to uncover, discover*; laden, *to load*, entladen, *to unload*. In this latter sense it is much used in forming verbs from nouns and adjectives. Thus, art, *kind, genus*, entarten, *to degenerate*; fremd, *strange*, entfremden, *estrange, alienate*; mutig, *courageous*, entmutigen, *to discourage*.

Er.—This originally means "forth, out." Compounded with simple verbs it often has the meaning of "attaining through the action of the verb." It denotes "up" in halten, *to hold*, erhalten, *to hold up, receive*. It denotes "beginning" in tönen, *to sound*, ertönen, *to begin to sound, sound forth*. It denotes "reversal" in schließen, *to shut*, erschließen, *to unshut, to open*. It intensifies the verbal idea in tragen, *to bear*, ertragen, *to endure*; leben, *to live*, erleben, *to experience*; setzen, *to place*, ersetzen, *to replace* (by a substitute). Its most characteristic meaning of "attaining" is found in eilen, *to hasten*, ereilen, *to overtake*; jagen, *to hunt*, erjagen, *to obtain by hunting*; trotzen, *to defy*, ertrotzen, *to get by defiance*. With adjectives it denotes "to make" (good, bad, etc.). Thus: schwer,

difficult, erſchweren, *to make difficult*; rot, *red*, erröten, *to blush*.

Ge.—This seems originally to have had the meaning "with," but it is difficult to trace. In such verbs as exist in a simple form and also compounded with ge, it is wellnigh impossible to make any difference between the two forms. Thus, frieren and gefrieren both mean *to freeze*. Gefallen originally meant to "fall in with," and hence *to please*; geſtehen means *to confess*.

A few verbs persist only in the compound form with ge, the simple form being no longer in use. Such are: Gebären, *to bear* (give birth to); geneſen, *to get well*; gelingen, *to succeed*. There are also a few syncopated forms in which the e has fallen out: Glücken, *to go well, succeed*, from gelücken; glauben, *to believe*, from gelauben; gleichen, *to resemble*, from geleichen.

Ver.—The original meaning of this is "forth, away." Like the other prefixes, it has, however, a number of other meanings. In the sense of "away" we have: Reiſen, *to travel*, verreiſen, *to travel away*; jagen, *to hunt* or *chase*, verjagen, *to chase away*. Akin to this meaning we have the sense of "exhausting or spoiling" by the action of the verb. Thus: Hungern, *to be hungry*, verhungern, *to die of starvation*; brauchen, *to use*, verbrauchen, *to wear out*; laufen, *to run*, ſich verlaufen, *to run in a wrong direction, to lose one's way*. It also denotes "to do a thing amiss." Thus: Raten, *to advise*, verraten, *to betray*; rechnen *to calculate*, verrechnen, *to miscalculate*. Sometimes it denotes a "reversal of the action of the verb." Thus: achten, *to respect*, verachten, *to despise*; bieten, *to bid*, verbieten, *to forbid*.

On the other hand, it may denote a "complete working out of the action of the verb." Thus: Bluten, *to bleed*, verbluten, *to bleed to death*; blühen, *to blossom*, verblühen, *to come to an end of blossoming, to wither*.

Again, it may be used like be and make an intransitive verb transitive. Thus: Lachen, *to laugh*, verlachen, *to laugh at, to mock*; dienen, *to serve*, verdienen, *to deserve*. In some cases it is difficult to classify the meaning. Thus: Treten, *to tread*, vertreten, *to represent*; ſehen, *to see*, verſehen, *to provide*.

A few verbs are used only in the compound form with ver, the simple form being no longer in use. Such are verderben, *to spoil, ruin*, verdrießen, *to vex*, vergeſſen, *to forget*, and verlieren, *to lose*. The verb freſſen from vereſſen means *to devour*.

Compounded with nouns, ver forms derivative verbs in which the prefix denotes "to cover with" or "to change into." Thus: Gold, *gold*, vergolden, *to cover with gold, to gild*; Stein, *stone*, verſteinern, *to change into stone, to petrify*.

Compounded with adjectives it forms verbs with the meaning of "to make" or "become." Thus: Kurz, *short*, verkürzen, *to shorten*; deutſch, *German*, verdeutſchen, *to turn into German*.

A great difficulty about verbs compounded with ver is that many of them have a variety of different meanings. The student will, however, gradually learn them by use.

Zer.—This has the meaning "apart," "asunder." Thus: Brechen, *to break*, zerbrechen, *to break into pieces*; ſtören, *to disturb*, zerſtören, *to destroy*.

Verbs with Separable Prefixes.—We shall now give examples of verbs compounded with separable prefixes, illustrating the most important meanings and uses of these prefixes.

Ab.—This mostly means "down" or "down from," "off." Thus: nehmen, *to take*, abnehmen, *to take off*; ſteigen, *to climb*, abſteigen, *to climb down* (hence to descend, alight); danken, *to thank*, abdanken, *to thank off*, i.e. to resign. Abnehmen (intrans.) means *to decrease*.

Compounded with words that already denote decrease, it strengthens the action of the verb. Thus: kürzen, *to shorten*, abkürzen, *to shorten, curtail*; mager, *lean*, abmagern, *to emaciate*; löſen, *to loosen*, ablöſen, *to detach, relieve*.

Akin to the idea of "off" is that of "ceasing an action" (compare English *leave off*), and hence of "completing" it. Thus: blühen, *to bloom*, abblühen, *to cease blooming*; nützen, *to use*, abnützen, *to make an end of using*, i.e. to use up; fertigen, *to get ready*, abfertigen, *to finish off, dispatch*.

From the idea of "taking a thing off another person" comes that of "getting a thing for oneself." Here we have an accusative of the thing obtained and a dative of the person from whom it is obtained. Thus: kaufen, *to buy* (einem Manne eine Sache) abkaufen, *to buy*; (a thing from a man); ſchmeicheln, *to flatter*, (einem etwas) abſchmeicheln, *to get* (something) *by flattery or coaxing* (from someone).

When compounded with verbs of motion it frequently denotes "away." Thus: reiſen, *to travel*, abreiſen, *to travel away*; fahren, *to drive, go*, abfahren, *to start*.

The following are similar to the English "*off*" in "*to reel off*": leiern, *to drawl*, (etwas) ableiern, *to drawl out* (something); ſingen, *to sing*, abſingen, *to sing off* (something).

It is also used in the sense of "copying off (or from) a thing." Thus: ſchreiben, *to write*, abſchreiben, *to transcribe*.

VOCABULARY

Mond, s.m.2, *moon.*
ewig, *eternal.*
ſchaffen, s., *to create.*
Licht, s.n.3, *light.*
Entſcheider, s.m.1, *arbiter.*
auf'gehen, s., *to rise.*
Kammer, w.f., *chamber.*
Siegesbahn, w.f., *career of victory.*
Farbe, w.f., *colour.*
Haupt, s.n.3, *head.*
Kraut, s.n.3, *herb.*
neidend, *jealous.*
vermögen, *to be able.*
plötzlich, *suddenly.*
Engel, s.m.1, *angel.*
Schickſal, s.n.2, *fate, doom.*
beneiden, w., *to envy.*
künftig, *henceforth.*
Irrtum, s.m.3, *mistake, error.*
verzeihen, s., *to forgive.*
verwandeln, w., *to change.*
zu'ſprechen, s., *to accost, cheer.*
Reue, s.f., *repentance.*
lechzen, w., *to pant, languish.*
ermatten, w., *to weary.*
tröſten, w., *to comfort.*
an'treten, s, *to enter upon.*
beweinen, w., *to bewail.*
mitleidig, *pitiful.*
inner, *inner.*
verjagen, w., *to chase away.*
Heer, s.n.2, *army.*
bleich, *pale.*
himmliſch, *heavenly.*
ſich erbarmen, w., *to have mercy.*
Rat, s.m.2, *council.*
ausgehen, s., *to go forth.*
Stimme, w.f., *voice.*
Firmament, s.n.2, *firmament.*
rollen, w., *to roll.*
Bräutigam, s.m.2, *bridegroom.*
Held, s.w.m., *hero.*
kleiden, w., *to clothe.*
umfließen, s., *to flow round about.*
duften, w., *to have a sweet scent.*
ſich ſchmücken, w., *to deck oneself.*
überglän'zen, w., *to outshine.*
Thron, s.m.2, *throne.*
hinwegſchwinden, s., *to vanish away.*
Gram, s.m., *grief.*
fließen, s., *to flow.*
todt, *dead.*
beſchämen, w., *to humiliate.*
weinen, w., *to weep.*
Weſen, s.n.1, *living being.*
finſter, *dark.*
heilig, *holy, sacred.*
unglücklich, *unhappy.*
verfinſtern, w., *to darken.*
Fehler, s.m.1, *fault.*
Wohl, s.n., *good.*
reuend, *repentant.*
Träne, w.f., *tear.*
Balſam, s.m., *balm.*
erquicken, w., *to revive, refresh.*
beleben, w., *to quicken.*
ſich wenden, w., *to turn.*
Gang, s.m.2, *walk, path.*
Schuld, w.f., *sin.*
ſuchen, *to seek.*
Führerin, w.f., *guide leader.*

Exercise 45

Sonne und Mond.

Vom Rate des Ewigen[1] ging die ſchaffende Stimme aus: „Zwei Lichter ſollen am Firmamente glänzen, als Könige der Erde, Entſcheider der rollenden Zeit."

Er ſprach; es ward[2]. Auf ging die Sonne, das erſte Licht. Wie ein Bräutigam am Morgen aus ſeiner Kammer tritt, wie ein Held ſich freuet[3] auf ſeine Siegesbahn: ſo ſtand ſie da, gekleidet in Gottes Glanz. Ein Kranz von allen Farben umfloß ihr Haupt; die Erde jauchzete, ihr[4] dufteten die Kräuter, die Blumen ſchmückten ſich.

Neidend ſtand das andere Licht und ſah, daß es die Herrliche[5] nicht zu überglänzen vermochte. „Was ſollen[6]," ſprach ſie murrend bei ſich ſelbſt, „zwei Fürſten auf einem Throne? Warum mußte ich die Zweite und nicht die Erſte ſein?" Und plötzlich ſchwand, von innerem Grame verjagt, ihr ſchönes Licht hinweg. Hinweg von ihr floß es weit in die Luft und ward das Heer der Sterne. Wie eine Todte[7], bleich, ſtand Luna da, beſchämt vor allen Himmliſchen[8], und weinte: „Erbarme Dich, Vater der Weſen, erbarme Dich."

Und Gottes Engel ſtand vor der Finſtern[9] da; er ſprach zu ihr des heiligen Schickſals Wort: Weil Du das Licht der Sonne beneidet haſt, Unglückliche[10], ſo wirſt Du künftig nur von ihrem Lichte glänzen; und wann[11] dort jene Erde vor Dich tritt, ſo ſtehſt Du, halb oder ganz verfinſtert da, wie jetzt. Doch, Kind des Irrtums, weine nicht. Der Erbarmende hat Dir Deinen Fehler verziehen und ihn in Wohl verwandelt. „Geh," ſprach er, „ſprich der Reuenden[12] zu. Auch ſie in ihrem Glanze ſei[13] Königin. Die Tränen ihrer Reue werden[14] ein Balſam ſein, der alles Lechzende[15] erquickt, der das vom Sonnenſtrahl Ermattete[16] mit neuer Kraft belebet[17]."

Getröſtet wandte ſich Luna; und ſiehe, da umfloß ſie jener Glanz, in welchem ſie jetzt noch glänzt. Sie trat ihn[18] an den ſtillen Gang, den ſie jetzt noch geht, die Königin der Nacht, die Führerin der Sterne. Beweinend ihre Schuld, mitleidig jeder Träne[19], ſucht ſie, wen ſie erquicke[20], ſie ſuchet[21], wen ſie tröſte.[21]

Herder.

NOTES:

(1) des Ewigen—this is an adjective used as a noun. There are many examples of such use in the above extract. Des Ewigen is, of course, gen. sing. of the mas. der Ewige; similarly, eine Todte is the fem. form of the adjective used as a noun, and alles Lechzende is the neuter of the adjectival use of the Pres. Part. (2) es ward—this literally means *it was*, or *it became*. It is best rendered in English by *it was so*. It is an imitation of Biblical language. (3) ſich freuen auf means *to look forward to.* (4) ihr, dative of interest; best translated by using the possessive adjective. (5) die Herrliche, *see* (1). (6) was ſollen, *what is the use of?* (7) eine Todte, *see* (1). (8) Himmliſchen, *see* (1). (9) Finſtern, *see* (1). (10) Unglückliche, *see* (1). (11) wann, modern German wenn, (12) Reuenden, *see* (1). (13) ſei, the Pres. Conj., used in reporting the words of a third person. (14) werden, Future Conj., *see* (13). (15) Lechzende, *see* (1). (16) Ermattete, *see* (1). (17) belebet, also Pres. Conj., *see* (13). (18) ihn—this temporary grammatical object anticipates the real logical object, den ſtillen Gang. (19) jeder Träne, dat. after mitleidig. (20) erquicke, tröſte—these Conjunctives indicate purpose. (21) ſuchet, the fuller form is older, and is used here in imitation of Biblical language.

VOCABULARY

abstemiousness, Enthaltſamkeit, w.f.
conquer, erobern, w.
Asia, Aſien, gen. Aſiens.
to be found, ſich befinden, s.
discover, auffinden, s. (sep.).
thirst for, lechzen (w.), nach.
pour, gießen, s.
lead on, weiterführen (w.) (sep.).
march, Zug, s.m.2.
desert, Wüſte, w.f.
nowhere, nirgends.
soldier, Soldat, w.m.
helmet, Helm, s.n.2.
only one, Einzige.
up, auf.
thirsty, durſtig.
mortal, ſterblich.
deem oneself, ſich halten (s.) für.
as long as, wenn.

Exercise 46

Alexander's Abstemiousness

Alexander the Great, on his march to conquer the world, came through a desert of Asia, in which there[1] was nowhere water to be found. At last a soldier had discovered some, and brought it in his

helmet to Alexander[2]. But as the latter saw that his soldiers thirsted for water just as much as he, he said: "Am[3] I to be the only one to drink[4]?" and poured the water on the ground. All, full of admiration at the abstemiousness of the king, exclaimed: "Up. Lead[5] on: we are not wearied, we are not thirsty. We do not deem ourselves mortal as long as such a king leads us."

NOTES:

(1) there. . . found, ſich nirgends Waſſer befand. (2) Alexander; prefix the, def. art. (3) am I to be? use ſollen. (4) to drink; say, who drinks there (da). (5) Lead on; supply the object uns in translating.

Key to Exercise 43

My mother never told me in what circumstances my father lived in the world; but if I call to mind all that she told me in my earliest youth about him, I am led (must) to believe that he was a worldly-wise man, endowed with profound knowledge. From these very stories, and from single remarks of my mother's about her former life, remarks that I did not understand till later on (that were only comprehensible to me later), I know that my parents sank from a life of ease, which they used to lead, thanks to the possession of wealth, into the bitterest and direst poverty; and that my father, tempted by Satan to the infamous crime, once committed a deadly sin for which, when in later years the grace of God enlightened him, he wished to atone by a pilgrimage to the sacred lime-tree in cold, far distant Prussia.

Key to Exercise 44

Pyrrhus und Fabricius

Pyrrhus, König von Epirus, führte Krieg mit Rom; gegen ihn wurde Fabricius ausgeſchickt. Als nun ſein und des Königs Lager ſich gegenüberſtanden, erſchien in der Nacht des letzteren Arzt bei Fabricius, und erklärte ſich gegen eine Belohnung bereit, Pyrrhus zu vergiften. Fabricius ließ dieſen Mann in Bande legen, zu ſeinem Herrn zurückführen, und Letzterem ſagen welche Pläne der Arzt wider ſein Leben gemacht hatte. Voll Bewunderung über dieſe Handlung des Fabricius, ſoll der König ausgerufen haben: Daran erkenne ich Fabricius, eher könnte die Sonne aus ihrer Bahn abgelenkt werden als dieſer Mann vom Pfade der Rechtſchaffenheit.

M. A. L.

RUSSIAN.—X

The Noun

101. *The Plural of Neuter Nouns (continued).*

Table H. Declensions of Irregular Neuter Nouns

Original	*Nominative*	*Genitive*	*Dative*	*Accusative*	*Instrumental*	*Prepositional.*
Колѣно *a tribe,*	Колѣна	Колѣнъ	Колѣнамъ	Колѣна	Колѣнами	О колѣнахъ
Колѣно *a knee,*	Колѣни	Колѣней	Колѣнямъ	Колѣни	Колѣнями	На колѣняхъ
Колѣно *a knot of a plant,* or *a joint of a chain,*	Колѣнья	Колѣньевъ	Колѣньямъ	Колѣнья	Колѣньями	Въ колѣньяхъ
Су́дно *a boat,*	Суда́	Судо́въ	Суда́мъ	Суда́	Суда́ми	На суда́хъ
Письмо́ *a letter,*	Пи́сьма	Пи́семъ	Пи́сьмамъ	Пи́сьма	Пи́сьмами	Въ пи́сьмахъ
Де́рево *a tree,*	Дере́вья	Дере́вьевъ	Дере́вьямъ	Дере́вья	Дере́вьями	На дере́вьяхъ
Плечо́ *a shoulder,*	Пле́чи	Плечъ	Плеча́мъ	Пле́чи	Плеча́ми	На плеча́хъ
О́ко *an eye,*	О́чи	Оче́й	Оча́мъ	О́чи	Оча́ми	Въ оча́хъ
У́хо *an ear,*	У́ши	Уше́й	Уша́мъ	У́ши	Уша́ми	Въ уша́хъ
Во́йско *an army,*	Войска́	Войскъ	Войска́мъ	Войска́	Войска́ми	О войска́хъ
Облако *a cloud,*	Облака́	Облако́въ	Облака́мъ	Облака́	Облака́ми	Въ облака́хъ
Око́шко *a window,*	Око́шки	Око́шекъ	Око́шкамъ	Око́шки	Око́шками	Объ око́шкахъ
Се́рдце *the heart,*	Сердца́	Серде́цъ	Сердца́мъ	Сердца́	Сердца́ми	Въ сердца́хъ
Лицё, лицо́ *a face, a person,*	Ли́ца	Лицъ	Ли́цамъ	Ли́ца	Ли́цами	О ли́цахъ
Яйцо́ *an egg,*	Я́йца	Я́йцъ	Я́йцамъ	Я́йца	Я́йцами	О я́йцахъ
Ружьё *a gun, rifle,*	Ру́жья	Ру́жей	Ру́жьямъ	Ру́жья	Ру́жьями	О ру́жьяхъ

Practice XXIII

(*a*) Change the following Datives Plural into Datives Singular :

Суда́мъ, ли́цамъ, сердца́мъ, оча́мъ, плеча́мъ

(*b*) Change the following Genitives Plural into Genitives Singular :

Яи́цъ, ру́жей, дере́вьевъ, войскъ, ушéй, пи́семъ.

(*c*) Change the following Prepositionals Plural into Prepositionals Singular :

На суда́хъ, на ли́цахъ, въ сердца́хъ, въ пи́сьмахъ, на колѣня́хъ, на дере́вьяхъ.

102. *Table I.—Full declension of Neuter Nouns ending in* **-мя**.

Example: Вре́мя, *the time.*

Singular

Nominative	*Genitive*	*Dative*	*Accusative*	*Instrumental*	*Prepositional*
Вре́мя	Вре́мени	Вре́мени	Вре́мя	Вре́менемъ	О вре́мени
		Plural.			
Времена́	Времёнъ	Временáмъ	Времена́	Временáми	О временáхъ

103. The Noun **сѣмя**, *a seed, has* **сѣмя́нъ** in Genitive Plural.

104. The Noun **дитя́**, *a child,* is declined as follows :

Singular

Nominative	*Genitive*	*Dative*	*Accusative*	*Instrumental*	*Prepositional*
Дитя́	Дитя́ти	Дитя́ти	Дитя́	Дитя́тею	О дитя́ти
		Plural			
Дѣти	Дѣте́й	Дѣтямъ	Дѣте́й	Дѣтьми́	О дѣтя́хъ

Practice XXIV

(*a*) Express in Genitive Singular the following :

И́мя, *a name.* Пле́мя, *a tribe.*
Бре́мя, *a burden.* Сѣмя, *the seed.*

(*b*) Express the above in Nominative Plural.

The Verb

Irregular Verbs (continued).

105. The Verbs : пить, *to drink ;* лить, *to pour, cast ;* шить, *to sew ;* бить, *to hit, beat, strike ;* вить, *to twine, plait, wind, build* (a nest)—are conjugated as follows :

PRESENT TENSE

Я	Ты	Онъ, она́, оно́	Мы	Вы	Они́, онѣ́, они́
Пью	Пьёшь	Пьётъ	Пьёмъ	Пьёте	Пьютъ
Лью	Льёшь	Льётъ	Льёмъ	Льёте	Льютъ
Шью	Шьёшь	Шьётъ	Шьёмъ	Шьёте	Шьютъ
Бью	Бьёшь	Бьётъ	Бьёмъ	Бьёте	Бьютъ
Вью	Вьёшь	Вьётъ	Вьёмъ	Вьёте	Вьютъ

IMPERATIVE

Sing.	*Plur.*
Пей	Пе́йте
Лей	Ле́йте
Шей	Ше́йте
Бей	Бе́йте
Вей	Ве́йте

PAST TENSE

Sing.			*Plur.*
Masculine	*Feminine*	*Neuter*	*All Genders*
Пилъ,	пи́ла,	пи́ло.	Пи́ли.
Лилъ,	ли́ла,	ли́ло.	Ли́ли.
Шилъ,	ши́ла,	ши́ло.	Ши́ли.
Билъ,	би́ла,	би́ло.	Би́ли,
Вилъ,	ви́ла,	ви́ло.	Ви́ли.

FUTURE TENSE

This is made up of the Infinitive of the principal verb preceded by the present tense of the verb "Быть."

Practice XXV

(*a*) Find the Infinitive of the following Indicatives of the Present tense :

Бью, зове́шь, иде́шь, кладе́шь, льёть, мóемъ, поютъ, пьютъ, прядёмъ, рóете, рвутъ, шлю, спишь, ткутъ, хóтятъ, шьютъ, ѣдемъ, ѣмъ, ѣду, ѣдимъ.

(*b*) Change into Infinitives the following Imperatives :

Бери́, бей, бѣги́те, жди́те, иди́, пóйте, пе́йте, шли, спи, ѣшьте.

(*c*) Find the Infinitive of the following Indicatives of Past tense :

Была́, би́ла, вёлъ, врала́, шли, могъ, нёсъ, пи́ла, пѣли, росъ, сла́ла, ѣлъ.

106. *Table J.—Conjugation of principal Irregular Verbs.*

Infinitive	*English*	The Present Tense						*Imperative*		The Past Tense			
								2nd person		*Singular*			*Plural*
		Я	Ты	Онъ, она́ оно́	Мы	Вы	Они́, онѣ́ они́	*Singular*	*Plural*	*Masculine*	*Feminine*	*Neuter*	*All Genders*
Мыть	*To wash*	Мо́ю	Мо́ешь	Мо́етъ	Мо́емъ	Мо́ете	Мо́ютъ	Мой	Мо́йте	Мылъ	Мы́ла	Мы́ло	Мы́ли
Рыть	*To dig*	Ро́ю	Ро́ешь	Ро́етъ	Ро́емъ	Ро́ете	Ро́ютъ	Рой	Ро́йте	Рылъ	Ры́ла	Ры́ло	Ры́ли
Пѣть	*To sing*	Пою́	Поёшь	Поётъ	Поём̀ъ	Поёте	Пою́тъ	Пой	По́йте	Пѣлъ	Пѣ́ла	Пѣ́ло	Пѣ́ли
Брать	*To take*	Беру́	Берёшь	Беретъ	Берём̀ъ	Берёте	Беру́тъ	Бери́	Бери́те	Бралъ	Бра́ла	Бра́ло	Бра́ли
Драть	*To tear off*	Деру́	Дерёшь	Деретъ	Дерём̀ъ	Дерёте	Деру́тъ	Дери́	Дери́те	Дралъ	Драла́	Дра́ло	Дра́ли
Звать	*To call*	Зову́	Зовёшь	Зоветъ	Зовём̀ъ	Зовёте	Зову́тъ	Зови́	Зови́те	Звалъ	Звала́	Зва́ло	Зва́ли
Красть	*To steal*	Краду́	Крадёшь	Крадетъ	Крадём̀ъ	Крадёте	Краду́тъ	Кради́	Кради́те	Кралъ	Кра́ла	Кра́ло	Кра́ли
Класть	*To lay, set*	Кладу́	Кладёшь	Кладетъ	Кладём̀ъ	Кладёте	Кладу́тъ	Кради́	Кради́те	Клалъ	Кла́ла	Кла́ло	Кла́ли
Прясть	*To spin*	Пряду́	Прядёшь	Прядетъ	Прядём̀ъ	Прядёте	Прядутъ	Пряди́	Пряди́те	Прялъ	Пряла́	Пря́ло	Пря́ли
Врать	*To tell lies*	Вру	Врёшь	Врётъ	Врём̀ъ	Вре́те	Врутъ	Ври	Ври́те	Вралъ	Врала́	Врало́	Вра́ли
Рвать	*To tear, pluck*	Рву	Рвёшь	Рвётъ	Рвём̀ъ	Рвёте	Рвутъ	Рви	Рви́те	Рвалъ	Рвала́	Рва́ло	Рва́ли
Ждать	*To wait*	Жду	Ждёшь	Ждетъ	Ждём̀ъ	Ждёте	Ждутъ	Жди	Жди́те	Ждалъ	Ждала́	Жда́ло	Жда́ли
Расти́	*To grow*	Расту́	Растёшь	Растётъ	Растём̀ъ	Растёте	Расту́тъ	Расти́	Расти́те	Росъ	Росла́	Росло́	Росли́
Слать	*To send*	Шлю	Шлёшь	Шлетъ	Шлём̀ъ	Шлёте	Шлютъ	Шли	Шли́те	Слалъ	Сла́ла	Сла́ло	Сла́ли
Ткать	*To weave*	Тку	Тчёшь	Тчётъ	Тчём̀ъ	Тчёте	Ткутъ	Тки	Тки́те	Ткалъ	Ткала́	Тка́ло	Тка́ли
Ѣсть	*To eat*	Ѣмъ	Ѣшь	Ѣстъ	Ѣди́мъ	Ѣди́те	Ѣдя́тъ	Ѣшь	Ѣшьте	Ѣлъ	Ѣ́ла	Ѣ́ло	Ѣ́ли
Ѣхать	*To ride, make a journey*	Ѣ́ду	Ѣ́дешь	Ѣ́детъ	Ѣ́демъ	Ѣ́дете	Ѣ́дутъ	По-ѣзжа́й	Поѣзжа́йте	Ѣ́халъ	Ѣ́хала	Ѣ́хало	Ѣ́хали
Хотѣть	*To want, be willing*	Хочу́	Хо́чешь	Хо́четъ	Хоти́мъ	Хоти́те	Хотя́тъ	Хоти́	Хоти́те	Хотѣлъ	Хотѣ́ла	Хотѣ́ло	Хотѣ́ли
Бѣжа́ть	*To run*	Бѣгу́	Бѣжи́шь	Бѣжи́тъ	Бѣжи́мъ	Бѣжи́те	Бѣгу́тъ	Бѣги́	Бѣги́те	Бѣжа́лъ	Бѣжа́ла	Бѣжа́ло	Бѣжа́ли
Спать	*To sleep*	Сплю	Спишь	Спитъ	Спимъ	Спи́те	Спятъ	Спи	Спи́те	Спалъ	Спала́	Спа́ло	Спа́ли
Нести́	*To carry*	Несу́	Несёшь	Несётъ	Несём̀ъ	Несёте	Несу́тъ	Неси́	Неси́те	Нёсъ	Несла́	Несло́	Несли́

The future is formed of present tense of быть *followed by the Infinitive of the Verb used.*

VOCABULARY

У Васъ	(u vas),	*at your place.*
Шёлкъ	(sholk),	*silk.*
Про́сто	(prósto),	*simply.*
Брани́ть	(bra-nítt),	*to scold.*
Язы́къ	(ya-zúk),	*the tongue.*
Болта́ть	(bal-tát'),	*to chat, babble.*
Во́ля	(vó-lya),	*freedom.*
Прихо́дъ	(pri-khód),	*coming, arrival.*
Бо́лѣе	(bó-lye-ye),	*over, more, above.*
Часъ	(chas),	*an hour.*
Часы́ (Plural only)	(cha-sü),	*a clock, watch.*
Прости́ть	(pra-stit'),	*to pardon.*
За́нять	(zá-nyat),	*busy.*
По́лночь	(pól-noch),	*midnight.*
Ча́стые	(chás-tü-ye),	*frequent.*
Ши́бко	(shíp-ko),	*quickly.*
Отписа́ть	(at-pi-sát'),	*to reply, write back.*
Чѣмъ скорѣе	(chyem skaryé-ye),	*the soonest possible.*
Спѣшное	(spyésh-no-ye),	*is urgent.*
Пріостанови́ть	(pri-as-ta-na-vít'),	*to stop.*
Плате́жъ	(pla-tyózh),	*payment.*
Вранье́	(vran'-yó),	*a lie, idle talk.*
Согласи́ться	(sa-gla-sit'-sya),	*to admit.*
Си́льно	(sil'-no),	*much, strongly.*
Пострада́ть	(pa-stra-dát'),	*to suffer.*
Пожа́ръ	(pa-zhár),	*a fire.*
Такъ что-жъ тако́е ?	(tak shtozh ta-kó-ye),	*well, what harm is there ?*
Страхо́вка	(stra-khóv-ka),	*insurance.*
Но	(no),	*but.*
Тѣмъ вре́менемъ	(tyem vré-mye-nyem),	*meanwhile.*
Не бѣда́	(nye bye-dá),	*no harm, no matter.*
Отдыха́ть	(at-dü-khát'),	*to have a rest.*
Немно́жко	nye-mnósh-ko),	*a bit, short while.*
Новѣ́йшіе	(na-vyéi-shi-ye),	*latest.*
Вельвети́ны	(vel'-ve-tí-nü),	*velveteens.*
Превосхо́дны	(pre-vas-khód-nü),	*are excellent.*
Су́дя	(sú-dya),	*judging by.*
Обра́зчикъ	(ab-ráz-chik),	*pattern.*
Мо́жно	(mózh-no),	*one can.*
Разсчи́тывать	(raz-schí-tü-vat'),	*reckon on.*
Спо́рую	(spó-ru-yu),	*a profitable.*
Переда́ть	(pe-re-dát'),	*to give over, hand over.*
Еди́нственное	(ye-dín-stven-no-ye),	*the sole, unique.*
Представи́тельство	(pred-sta-ví-tyel'-stvo),	*representation.*
На всю	(na vsyu),	*for the whole of.*
Разви́тіе	(raz-ví-ti-ye),	*development.*
Позволя́ть	(pa-zva-lyát'),	*to allow.*
Сосредото́чивать	(sa-sre-da-tó-chi-vat'),	*to concentrate.*
Интере́сы	(in-tye-ré-sü),	*interests.*
Въ одно́мъ	(v ad-nyékh),	*in single (ones).*
Тяжёлое	(tya-zhó-lo-ye),	*a heavy.*
Шумѣ́ть	(shu-myét'),	*to make a noise.*
Мя́со	(myá-so),	*meat.*
Теа́тръ	(tye-átr),	*theatre.*
У меня́ нѣтъ	(u mye-nyá nyet),	*I have no.*
Швейца́рія	(shvei-tsá-ri-ya),	*Switzerland.*
Ду́мать	(dúmat'),	*to intend, think of doing.*
Ба́ловаться	(bá-lo-vat'-sya),	*to have a bit of fun.*
Ра́звѣ	(ráz-vye),	*is it then that.*
Имъ	(im),	*there is for them.*
Не́чево	(nyé-che-vo),	*nothing.*
Обѣ́денное вре́мя	(a-byé-dyen-no-ye vré-mya).	*dinner time.*
Верну́ться	(vyer-nút'-sya),	*to go back.*
Со дня на́ день.	(sa dnya ná dyen').	*from day to day.*

Exercise 16

Translate the following into English :—

1 Какъ шёлкъ (was selling) у Васъ мой шёлкъ ?
2. Его́ про́сто рва́ли съ (from) рукъ.
3. Языко́мъ, что хо́чешь болта́й, а рука́мъ во́ли не дава́й.
4. Я ждалъ Ва́шего прихо́да бо́лѣе ча́са.
5. Прости́те, пожа́луйста, я былъ о́чень за́нятъ.
6. Не хвали́ въ о́чи, не брани́ за глаза́.
7. Часы́ бьютъ по́лночь.
8. Шлётъ ли Петрогра́дъ Вамъ ча́стые зака́зы ?
9. Да, нашъ това́ръ тамъ продаётся о́чень ши́бко.
10. Пожа́луйста, отпиши́те чѣмъ скорѣе : дѣло спѣшное.
11. Говори́тъ, что Бра́тья Б. пріостанови́ли платежи́.
12. Не мо́жетъ быть. Это вранье́.
13. Вы согласи́тесь, что они́ си́льно пострада́ли отъ пожа́ра.
14. Такъ что-жъ тако́е : они́ бу́дутъ получа́ть страхо́вку.
15. Но они́ тѣмъ вре́менемъ теря́ютъ торго́влю.
16. Не бѣда́. Пусть немно́жко отдыха́ютъ.
17. Ва́ши новѣ́йшіе вельвети́ны превосхо́дны.
18. Су́дя по обра́зчикамъ мо́жно разсчи́тывать на спо́рую прода́жу.
19. Мо́жете ли Вы мнѣ переда́ть еди́нственное представи́тельство на всю Россі́ю ?
20. Разви́тіе на́шихъ дѣлъ не позволя́етъ намъ (us) сосредото́чивать на́шихъ ру́сскихъ интере́совъ въ одно́мъ рука́хъ.

Exercise 17

Translate the following into Russian :—

1. I carry on my (the) shoulders a heavy burden.
2. He is enjoying a good (хоро́шимъ) name (Instrumental).
3. The children are making a noise.
4. Why do you not eat ?
5. I do not want, I cannot, I do not eat meat.
6. Why do you not go to the theatre ?
7. I have no time.
8. Do you drink wine ?
9. I drink no (никаки́хъ) wines.
10. When do you go (ѣхать) to (въ) Switzerland (Accusative) ?
11. I intend going there (туда́) in (че́резъ) a month.
12. Who is singing there ? (тамъ)
13. These are my employees (прика́щики) having a bit of fun (Translate : This (neuter) my employees have, etc.).
14. Have they then nothing to do ?
15. It is their (ихъ) dinner time.
16. Where (куда́) does the boy run : call him back (наза́дъ).
17. He does not want to go back.
18. I read and write without eyeglasses (очки́, masc. Plural).
19. I am waiting for letters from Moscow (Москва́).
20. Our business is growing from day to day.

A. O.

Continued from page 294.

GEOGRAPHY:

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NORTH AMERICA.—II

THE Cordillera region occupies the west of the North American continent from about the centre of Mexico up to the Arctic Ocean. Its greatest breadth is attained in the United States where in some parts it is about 1,000 miles across.

The Cordillera systems begin more or less abruptly towards the south of Mexico where they have roughly an east and west direction. There are in Mexico three main ranges, one along the Gulf of Mexico, one along the Pacific coast, and the third forming the backbone of the peninsula of Lower California. Between the two former ranges are many shorter, transverse spurs, and the general level of the plateau is about 6,000 feet above sea level, though the peaks rise to 12,000 feet. The climate of this region is excessively arid owing to the lack of rain, and the vegetation is mostly of a desert character. Enclosed in this plateau are several inland drainage areas with saline and alkaline lakes which, however, are not of large size.

Death Valley

Where the Cordillera reaches the boundary between Mexico and the United States the width is about 700 miles, and this part of the region is called the Rocky Mountains. This is, however, a rather indefinite term which properly speaking should be confined to the eastern portion of the Cordillera, that is the high ground situated between the base of the great plains on the east and the " Great Basin " of inland drainage on the west.

The Great Basin is, as has been said above, an inland drainage system over 200,000 square miles in area and the rivers flowing westward from the Rockies empty themselves into its lakes, such as the Great Salt Lake in Utah, etc. It possesses an arid climate. The floor of the Great Basin is not flat, but is traversed by rugged ranges of hills dividing it into smaller basins. Some of the lakes in the basin are fresh, others are salt. Great Salt Lake itself is a shallow sheet of water with a mean depth of only from 20 to 30 feet and of an area of 2,360 square miles. A remarkable district of the Great Basin is known as Death Valley. This is the only part of North America which is below the sea level, and it descends in parts to 130 feet below the level of the Pacific Ocean.

The eastern boundary of the Great Basin is formed by the Wasatch Range of the Rockies. On the western boundary are the Sierra Nevada and the Cascade ranges, the Rocky Mountains bending round the northern extremity of the basin to join the latter.

Yellowstone Park

In the state of Wyoming occurs what is known as the Laramie Plateau, a tract of elevated land about 7,000 feet high which separates the Rocky Mountains into two portions and across which passes the Union-Pacific Railway. To the north of the Laramie plateau occur the Big Horn Mountains and the Teton Range, in the north of which latter is situated the celebrated Yellowstone Natural Park, containing within its boundaries some of the most magnificent natural scenery in the continent including the famous Geyser basin, the largest of the three known in the world.

In Canada the Rocky Mountains form four main ranges with an average breadth of 400 miles and, although not so high as parts in the United States, the peaks in some places reach a height of 13,000 feet. Mount Robson, the highest peak in the Canadian Rockies, rises to 13,700 feet.

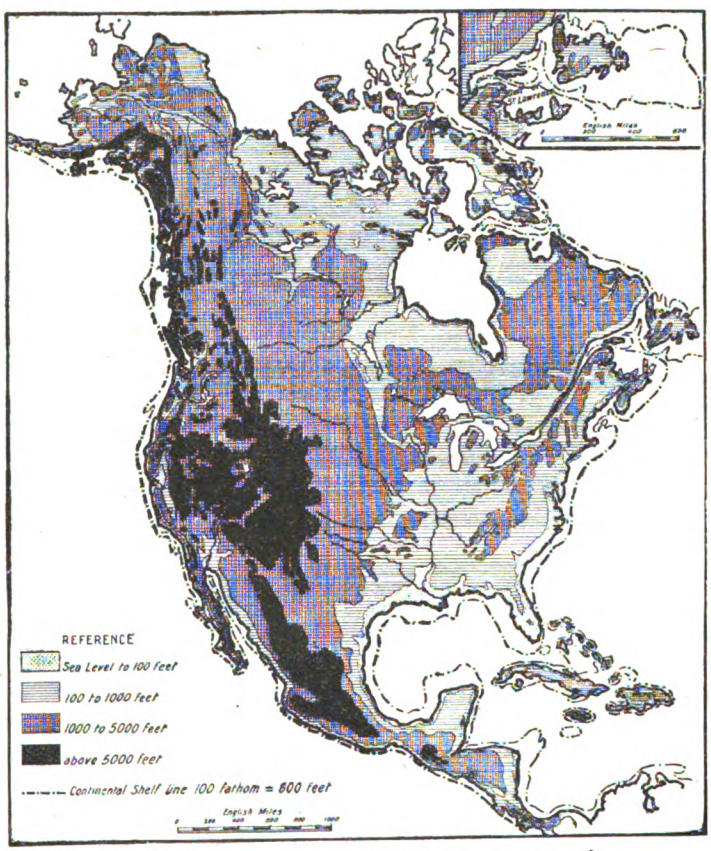
In the South Rockies, in adjoining portions of the states of Utah, Colorado, Arizona and New Mexico occur what are known as the high plateaux, of a general elevation of six to seven thousand feet and drained by the Colorado River. Here the rocks form nearly horizontal stratified formations of a total thickness of about 13,000 feet. The rainfall

on these plateaux is very slight, while on the mountains to the east and north the precipitation is much greater. Here the Green and Grand Rivers unite to form the Colorado River which falls into the Gulf of California. This river, in the course of centuries, has worn a channel in the comparatively rainless region and, acting like a huge saw, has cut a nearly vertical trough through the enormous thickness of stratified rocks to form what is known as a Cañon. The region through which it flows being so dry there has been no opportunity for transverse streams to widen the "valley." This "Great Cañon" of the Colorado River is more than 200 miles long and from five to twelve miles wide, with a depth of about 6,000 feet. The cliffs bounding it are wellnigh vertical and the gorgeous and varied colours of the rocks together with the vast size and infinite details of the cañon make it one of the most impressive sights on the globe.

Yosemite Valley

In the Sierra Nevada is found the highest mountain in the United States, Mt. Whitney, 14,500 feet high. Curiously enough it is within a hundred miles of Death Valley, already referred to as the lowest depression of land on the continent. In this range of mountains also is situated the celebrated Yosemite Valley in the Yosemite National Park. This is a magnificent cleft in granite rocks due to stream and ice action. It is over a mile deep and has precipitous and nearly vertical walls. The whole range is noted for its wonderful scenery and abounds with glacier lakes.

In the Cascade Mountains, in the state of Oregon, is situated Mount Mazama, a truncated volcanic cone. The top of this is now filled with water forming "Crater Lake," a unique sheet of water some five to six miles across and enclosing a small island, which itself was a volcanic cone formed after the summit of the mountain had fallen in. Crater Lake has a depth of 2,000 feet, and the cliffs bounding it rise in places to nearly 2,000 feet above the level of the water, the whole depth of the depression being thus about 4,000 feet. The scenery around the lake is certainly very beautiful, the outer slopes of the mountain being forest covered, while the inner crags are of bare and jagged rock set off very brilliantly against the blue waters of the lake beneath them.



OROGRAPHY OF NORTH AMERICA.

To the west of the Sierra Nevada and Cascade ranges is another much lower line of heights which are known as the Coast Ranges.

These extend from California well into Canada, and between them and the higher mountains to the east occur a series of long and narrow valleys, the chief of which is the great valley of California. This valley has a length of about 500 miles and a breadth of some 40 miles. The northern half of this valley drains southward by the Sacramento River, the southern half northward by the San Joaquin River. At San Francisco the two streams unite and fall into San Francisco Bay.

This great valley, larger in area than the whole of Belgium, is of extraordinary fertility, and bears on its surface, besides large areas of wheat fields, innumerable orchards and vineyards. Farther north, just southward of the international boundary, is another valley, the base of which is filled by the sea. This is the Puget Sound Basin, and it is evident from the character of the inlet—the deep and narrow channels and the nature of the sound—that this is a fiord formation caused by the drowning of glaciated valleys.

Generally speaking the Coast Ranges are of inferior elevation to the Cascade Mountains on their east, but some of the peaks in the Canadian portion rise to over 8,000 feet.

The Yukon District

Further north still, on the borders of Canada and Alaska, the Coast Range attains a greater elevation and in the Yukon district of Canada occurs Mt. Logan, a magnificent, ice-covered peak nearly 20,000 feet high. In Alaska itself, further to the west is Mt. McKinley, over 20,000 feet high, the highest peak in North America. The snowline here is only some 2,500 feet above sea level, and magnificent glaciers descend right to the sea. The mountains here rise directly from the ocean and are exceedingly rugged and precipitous. In the Alaska peninsula and its prolongation, the Aleutian Islands, there are many active volcanoes.

Drainage Basins

The mountain range of the western Cordillera forms the great watershed of the North American Continent. The rivers which rise on the western slopes and between the ranges west of the Rocky Mountains drain to the Pacific Ocean. Chief among these are the Yukon, Fraser, Columbia and Colorado Rivers.

The Yukon River rises in the Yukon territory of Canada and flows in a semi-circular direction through Alaska to its mouth in the Behring Strait. It is about 2,300 miles long and is navigable for about three months from the mouth to Dawson in Canada. From its source, only fifteen miles from Dyea inlet in British Columbia, to the Canada-Alaska boundary it passes

Photo: by permission of the C. P. Railway.

FRASER RIVER.

in British Columbia, is 750 miles long and navigable for some 200 miles; it flows through some remarkably picturesque cañons.

through the gold regions discovered in the year 1896.

The Fraser River in British Columbia drains a basin between the Rocky Mountains and the Cascade Range. It is some 750 miles long and is navigable for steamboats for about 200 miles. For a portion of its course it flows through a series of big picturesque cañons.

The Columbia River rises in the Canadian territory of British Columbia and flows in a southerly direction through the Arrow Lakes into the State of Washington. Some 200 miles from the sea it turns westward and enters the Pacific Ocean near Astoria, forming the boundary between Washington and Oregon States. This river, like the Fraser, drains a district between the Rockies and the Cascades. The total length of the Columbia River is 1,400 miles, half of which is in British territory, and the length of its longest fork, the Snake River, 940 miles.

The Columbia River is navigable for about 150 miles as far as the cascades, where it passes through the Cascade Range, and above this point, where there are rapids, through another 200 miles, though interrupted at intervals again by rapids. It is famous for the quantity of salmon caught in its waters.

The Colorado River is formed in south-east Utah by the junction of the Grand and Green Rivers. For the greatest part of its course the Colorado and all its tributaries flow through barren country in a system of cañons unique in the globe. The Grand Cañon on the Colorado has already been described. The lower course of the Colorado is through a desert country of low elevation and the river empties itself after traversing a course of over 1,000 miles into the Gulf of California.

The Green River, its largest fork, is a further 800 miles long.

From the eastern slopes of the Rocky Mountains flow the largest of the North American rivers.

The Peace River flows towards the Arctic Ocean. This enters the Slave River 30 miles north of Lake Athabasca, which flows into Great Slave Lake, and from this lake, as the Mackenzie, flows into the Arctic Ocean. The whole of this great drainage basin is some 500,000 square miles, and the

Photo: by permission of the Government of Canada.

MOUNT ROBSON

rises to 13,700 feet and is the highest peak in the Canadian Rockies.

combined rivers have a length of over 2,500 miles, for 2,000 miles of which they are navigable. Like the rivers of Siberia the more southerly portions thaw earlier in the year than the lower reaches, and great floods are consequently formed in spring towards the mouth.

The Saskatchewan River is formed by the junction of the north and south Saskatchewan Rivers, and flows through Lake Winnipeg, leaving this as the Nelson River, which empties itself into Hudson Bay. The total length of the Saskatchewan-Nelson River is about 1,500 miles.

The chief tributaries are the Red Deer River, Battle River and Red River of the North.

The most important river flowing into the Atlantic Ocean is the St. Lawrence, which drains the Great Lakes. Considering it in connection with the Great Lakes it may be regarded as being about 2,400 miles long, though in different portions of the combined course it goes under different names. This river is the largest as to volume in the continent and only comes second to the Mississippi-Missouri in length.

Great Rivers

It flows from Lake Ontario into the Gulf of St. Lawrence. For some distance below Lake Ontario it forms the boundary line between Canada and the United States of America. Its chief tributaries are the Ottawa, the Richelieu, St. Francis, St. Maurice, Saguenay and Chaudière. The Thousand Islands are contained by it.

Into the Gulf of Mexico flows the Mississippi, the longest river in North America. It rises in Lake Itasca, a small lake in the state of Minnesota not much more than 100 miles from the northern boundary of the United States, and flows in a general north and south direction for 2,500 miles into the sea through a large delta at New Orleans. On the east it receives the Ohio River which with all its affluents drains the western slopes of the Appalachian Mountains. On the west the chief tributaries are the Missouri, Arkansas and Red Rivers, which drain the eastern slopes of the Rocky Mountains. The Missouri, its longest tributary, rises in Montana and has an irregular course, firstly north and north-east and then almost due east. In North Dakota it turns south-east and pursues a course in this direction until, near Kansas City, it finally turns east and passes through the state of Missouri to its junction with the Mississippi twenty miles north of St. Louis.

Mississippi Delta

The length of the Missouri is about 3,000 miles, the combined length of the two rivers is about 4,000 miles, but the entire length of navigable waterways in the immense drainage system, which is over a million and a quarter square miles in area, is about 15,000 miles. There are three main " passes " or branches of the river through the delta into the sea, and by a system of jetties the waters of the South Pass are made to scour out a passage through the silt forming a bar that is brought down by the stream, so that a channel of over 30 feet in depth is practicable for the largest vessels up as far as New Orleans.

The Rio Grande del Norte rises in the San Juan Mountains of Colorado, and after flowing south across the state of New Mexico becomes at El Paso the southern boundary of the United States. Thence it flows generally south-east into the Gulf of Mexico. It is 1,800 miles long, but during the summer months it is nearly dry as it enters the state of Texas.

C. J. S.

THE HARBOUR OF ST. JOHN, NEW BRUNSWICK.

Continued from page 300.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A.[Lond.]).

ALGEBRA.—XXI

126. Variation.—A MAGNITUDE A is said to **vary as** a magnitude B, if when B is changed A is changed in the *same ratio.*

The symbol $\propto$ denotes variation, and $A \propto B$ is read A varies as B.

If $a_1, a_2, a_3, \ldots\ldots$ and $b_1, b_2, b_3 \ldots\ldots$ be corresponding values of A and B.

Then by definition, if $A \propto B$

$\frac{A}{a_1} = \frac{B}{b_1}$; $\frac{A}{a_2} = \frac{B}{b_2}$; $\frac{A}{a_3} = \frac{B}{b_3}$; and so on

$\therefore \frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3} = \ldots\ldots = \frac{A}{B}$.

Thus we see the ratio of any value of A to the corresponding value of B is always the same, and is equal to $\frac{A}{B}$.

Hence $\frac{A}{B}$ is constant, and if we put m for this constant, we have $\frac{A}{B} = m \therefore A = mB$.

To find the value of this constant m we need only divide any value of A by the corresponding value of B.

One quantity is said to vary **inversely** as another, when the first varies as the **reciprocal** of the second.

Thus a varies inversely as b, if the ratio $a : \frac{1}{b}$ is constant and hence $ab = m$.

One quantity is said to vary as two others **jointly,** when the first varies as the **product** of the other two.

Thus a varies jointly as b and c where $a : bc$ is constant and hence $a = mbc$.

One quantity varies **directly** as a second quantity and **inversely** as a third when the ratio of the first to the **product** of the second and the reciprocal of the third is constant.

Thus a varies directly as b and inversely as c When $a : \frac{b}{c}$ = constant and hence $a = \frac{mb}{c}$.

In all the above cases, the constant m is determined when one set of corresponding values of all the variables is given.

127. *If a depends only on b and c, in such a way that a varies as b when c is constant, and varies as c when b is constant, then a will vary as bc.*

Let $a_1\ b_1\ c_1$; a_2, b_2, c_1; a_3, b_2, c_2, be three sets of corresponding values.

Then since c_1 is the same in the 1st and 2nd,

$\frac{a_1}{a_2} = \frac{b_1}{b_2}$ ..... (i)

and since b_2 is the same in the 2nd and 3rd,

$\frac{a_2}{a_3} = \frac{c_1}{c_2}$ ..... (ii)

Multiplying corresponding sides of (i) and (ii) we have $\frac{a_1}{a_3} = \frac{b_1 c_1}{b_2 c_2}$ which proves the theorem.

Example:—

The pressure of a gas varies as the density when the temperature is constant; also the pressure varies as the absolute temperature when the density is constant; hence when both density and temperature change, the pressure will vary as the product of the density and temperature.

128. A ratio sometimes assumes an indeterminate form for some value or values of one of the letters involved.

Consider the fraction $\frac{x^2 - x}{x^3 - x}$. When $x = 0$ both the numerator and the denominator vanish and we get the form $\frac{0}{0}$. We get the same form if $x = 1$. On the other hand, when $x = \infty$, the fraction assumes the form $\frac{\infty}{\infty}$.

These forms are indeterminate, and we will now show how to find limiting values of these forms.

Consider $\frac{x^2 - 1}{x^3 - 1}$, this fraction becomes $\frac{0}{0}$, when $x = 1$.

Now $\frac{x^2 - 1}{x^3 - 1} = \frac{(x-1)(x+1)}{(x-1)(x^2 + x + 1)}$, and *so long as* $(x - 1)$ *does not actually equal zero,* we may divide numerator and denominator by $(x - 1)$ without altering the value of the fraction; we may do this *however small* $(x - 1)$ *may be.*

Hence when $(x - 1)$ is *very small* $\frac{x^2 - 1}{x^3 - 1} = \frac{x + 1}{x^2 + x + 1}$ and the limiting value of the latter fraction when x approaches indefinitely close to the value 1, is $\frac{2}{3}$.

Thus as x approaches indefinitely near the value 1, $\frac{x^2-1}{x^3-1}$ approaches indefinitely near the value $\frac{2}{3}$. We express this by saying that the limiting value of $\frac{x^2-1}{x^3-1}$, when x approaches indefinitely near the value 1, is $\frac{2}{3}$.

The notation used is $\mathrm{L}_{x=1} \frac{x^2-1}{x^3-1} = \frac{2}{3}$.

Examples :—

(1) Find the limiting value of $\frac{x^2-7x+10}{x^2-9x+14}$ when $x = 2$, and when $x = \infty$

$$\mathrm{L}_{x=2} \frac{x^2-7x+10}{x^2-9x+14} = \mathrm{L}_{x=2} \frac{(x-2)(x-5)}{(x-2)(x-7)} = \mathrm{L}_{x=2} \frac{x-5}{x-7} = \frac{3}{5}$$

$$\mathrm{L}_{x=\infty} \frac{x^2-7x+10}{x^2-9x+14} = \mathrm{L}_{x=\infty} \frac{x-5}{x-7}$$

$$= \mathrm{L}_{x=\infty} \frac{x\left(1-\frac{5}{x}\right)}{x\left(1-\frac{7}{x}\right)} = \mathrm{L}_{x=\infty} \frac{1-\frac{5}{x}}{1-\frac{7}{x}} = 1 \left(\because \frac{5}{x} = 0 \text{ and } \frac{7}{x} = 0 \text{ when } x = \infty\right).$$

Exercise 30

(1) If $x \propto y$, and $y = 3$ when $x = 2$, find y, when $x = 18$.

(2) If $x \propto \frac{1}{y}$, and $y = 4$ when $x = 15$, find y when $x = 6$.

(3) If x varies directly as y and indirectly as z, and $x = 10$ when $y = 15$ and $z = 6$, find x when $y = 8$ and $z = 2$.

(4) The area of a circle varies as the square of its radius ; the area of a circle whose radius is 10 inches is 314·159 square inches. Find the area of a circle whose radius is 4 inches.

(5) Find the limiting value of $\frac{x^2+6x-16}{x^3-12x+16}$ when $x = \infty$.

(6) Find the limiting value of $\frac{x^2+2x}{2x^2+3x}$ when $x = 0$.

129. A succession of magnitudes, each of which is formed according to a definite law, is called a **series.**

Thus 1, 2, 3, 4 ..... in which each term * exceeds the preceding one by unity, is a series.

Again 1, 2, 4, 8, 16 ..... in which each term is double of the preceding one, is a series.

130. Arithmetical Progression.

A series in which the difference between any term and the one immediately preceding it is always the same, is called an **Arithmetical Progression.**

Thus if a, b, c, d, are in Arithmetical Progression (usually written A. P.), then $b - a = c - b = d - c$.

The difference between each term of an A. P. and the preceding term is called the **common difference.**

* The student should note that " term " is not used here in the same sense as that defined in Lesson V.

Thus 1, 4, 7, 10 .... is an A. P. with common difference 3

Again 5, 3, 1, − 1, − 3, ... is an A. P. with common difference − 2

And $\frac{3}{4}, \frac{5}{4}, \frac{7}{4}, \frac{9}{4}, \ldots$ is an A. P. with common difference $\frac{1}{2}$.

Let the first term of an A. P. be a, and the common difference d. Then by definition :—

The second term is $a + d$

The third term is $a + 2d$

The fourth term is $a + 3d$.

It will be noticed that the co-efficient of d is always less by unity than the number which indicates the position of the term. Hence the nth term will be $a + (n - 1)d$.

Thus we can write down any term of an A. P. given the first term and the common difference.

An A. P. is determined when any two of its terms are given.

For, suppose the mth term is α and the nth term is β.

Let a be the first term and d the common difference.

Then the mth term will be $a + (m - 1)d$, and the nth term will be $a + (n - 1)$ d.

Hence $\alpha = a + (m - 1)d$ and $\beta = a + (n - 1)d$ and these are two equations to determine a and d.

Example :—

The fourth term of an A. P. is 9, and its twelfth term is 25. Find the seventh term.

If a be the first term and d the common difference, then, $a + 3d = 9$ and $a + 11d = 25$.

$\therefore d = 2, \quad a = 3$

and the seventh term $= a + 6d = 3 + 12 = 15$.

When three quantities are in A. P., the middle one is called the **Arithmetical Mean** of the other two. If a, b, c are in A. P. then by definition $b - a = c - b \therefore b = \frac{1}{2}(a + c)$.

Thus *the Arithmetical Mean of two given quantities is half their sum.*

When any number of quantities are in A. P. all the terms between the first and last may be called Arithmetical Means of the extreme terms.

Between any two given quantities, any number of Arithmetical Means may be inserted.

For, let a and b be the two quantities, and let n be the number of means it is required to insert. Then b will be the $(n + 2)$th term of the A. P., whose first term is a.

If d be the common difference, then

$$b = a + (n + 1)d \quad \therefore d = \frac{b-a}{n+1}.$$

Hence the series is

$$a, a + \frac{b-a}{n+1}, a + 2\frac{b-a}{n+1} \ldots\ a + n\frac{b-a}{n+1}, b$$

$\therefore$ the required Arithmetical Means are

$$a + \frac{b-a}{n+1}, a + 2\frac{b-a}{n+1} \ldots\ a + n\frac{b-a}{n+1}$$

or $\frac{na+b}{n+1}, \frac{(n-1)a+2b}{n+1} \ldots \frac{a+nb}{n+1}$

To find the sum of any number of terms of an A. P.

Let a be the first term and d the common difference,

Let n be the number of terms required and l the last term

Then since l is the nth term

$$l = a + (n-1)d \quad \ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Hence if S is the required sum

$$S = a + (a+d) + (a+2d) + (a+3d) + \ldots\ldots + (l-2d) + (l-d) + l.$$

If we write this series in the reverse order, we have

$$S = l + (l-d) + (l-2d) + (l-3d) + \ldots\ldots + (a+2d) + (a+d) + a.$$

Now add the corresponding terms, and we have

$2S = (a+l) + (a+l) + (a+l) + \ldots\ldots$ to n terms $= n(a+l)$

$$\therefore S = \frac{n}{2}(a+l) \quad \ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

and substituting for l from (i)

$$S = \frac{n}{2}\{2a + (n-1)d\} \quad \ldots\ldots\ldots\ldots \text{(iii)}$$

From (i), (ii) and (iii) we can find the value of all the quantities a, d, n, l, S, when any 3 of them are given.

Examples :—

(1) Find the sum of 21 terms of the A. P. 3, 5, 7, 9 .....

Here $a = 3$, $d = 2$, $n = 21$

$$\therefore S = \frac{21}{2}\{2 \times 3 + 20 \times 2\} = 483$$

(2) How many terms of the series $15 + 11 + 7 +$ .....must be taken, so that the sum may be 35 ?

Here $a = 15$, $d = -4$, $S = 35$

$$\therefore 35 = \frac{n}{2}\{2 \times 15 + (n-1)(-4)\}$$

$$\therefore 2n^2 - 17n + 35 = 0$$

i.e. $(n-5)(2n-7) = 0 \therefore n = 5$

The value $n = \frac{7}{2}$ may be rejected since n must be a whole number. Hence the number of terms required is 5.

131. Geometrical Progression.

A series of quantities is said to be a **Geometrical Progression** (G. P.), when the ratio of any term to the immediately preceding term is the same throughout the series.

Thus a, b, c, d are in G. P. if $\frac{b}{a} = \frac{c}{b} = \frac{d}{c} \ldots\ldots$

The ratio of each term to the preceding term is called the **common ratio.**

Thus 1, 2, 4, 8 ..... is a G. P. with the common ratio 2.

Again 2, -6, 18, -54 ..... is a G. P. with the common ratio -3.

And 2, 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ ..... is a G. P. with the common ratio $\frac{1}{2}$.

If the first term of a G. P. be a and the common ratio r then by definition

the second term is ar

the third term is ar^2

the fourth term is ar^3.

The index of r is always less by unity than the number indicating the position of the term in the series.

Hence the nth term is ar^{n-1}.

Thus we can write down any term of a G. P. when the first term and common ratio are given.

Thus in a G.P. whose first term is $\frac{3}{2}$ and whose common ratio is 2, the sixth term would be $\frac{3}{2} \times 2^5 = 48$.

A G. P. is determined when any two of its terms are given.

Suppose the mth term is α and the nth term is β. Let a be the first term and r the common ratio then by definition $\alpha = ar^{m-1}$ and $\beta = ar^{n-1}$

$$\therefore r^{m-n} = \frac{\alpha}{\beta}$$

$$\therefore r = \alpha^{\frac{1}{m-n}} \beta^{\frac{1}{n-m}} \quad \text{and} \quad \therefore a = \alpha^{\frac{1-n}{m-n}} \beta^{\frac{1-m}{n-m}}$$

Example :—

Find the first term of a G. P. whose third term is 18 and whose fifth term is 162.

If a be the first term and r the common ratio then $ar^2 = 18$ and $ar^4 = 162 \therefore r^2 = 9$

$\therefore a \times 9 = 18 \therefore a = 2$.

Thus the series is 2, 6, 18, 54, ...

When three quantities are in G. P., the middle term is called the **Geometric Mean** of the other two.

If a, b, c, be in G. P. then by definition

$$\frac{b}{a} = \frac{c}{b}; \therefore b = \pm\sqrt{ac}$$

Hence *the geometric mean of two quantities is the square root of their product.*

When any number of quantities are in G. P. all the terms between the first and the last may be called *Geometric Means* of the two extreme terms.

Any number of geometric means may be inserted between two given quantities.

Let a and b be the two given quantities, and let n be the number of means to be inserted. Let r be the common ratio.

Then $b = ar^{n+1} \therefore r = \sqrt[n+1]{\frac{b}{a}}$

Hence the required means are

$$ar, ar^2, ar^3 \ldots\ldots ar^{n-1}, ar^n$$

that is $a^{\frac{n}{n+1}} b^{\frac{1}{n+1}}, a^{\frac{n-1}{n+1}} b^{\frac{2}{n+1}}, a^{\frac{n-2}{n+1}} b^{\frac{3}{n+1}} \ldots\ldots$

$a^{\frac{2}{n+1}} b^{\frac{n-1}{n+1}}, a^{\frac{1}{n+1}} b^{\frac{n}{n+1}}$

To find the sum of any number of terms in G. P.

Let a be the first term, and r the common ratio. Let n be the number of terms whose sum is required and let l be the last term.

Since l is the nth, we have $l = ar^{n-1}$.

If S be the required sum

$$S = a + ar + ar^2 + ar^3 + \ldots\ldots + ar^{n-2} + ar^{n-1}.$$

Multiply by r then

$$Sr = ar + ar^2 + ar^3 + ar^4 + \ldots\ldots + ar^{n-1} + ar^n$$

Subtracting the corresponding terms

$$S - Sr = a - ar^n$$

$$\therefore S = a\frac{(1-r^n)}{1-r}$$

Example :—

Find the sum of 10 terms of the series 1, 2, 4, 8....

$a = 1$, $r = 2$, $n = 10$

$$\therefore S = 1 \times \frac{(1-2^{10})}{(1-2)} = 1 \times \frac{2^{10}-1}{2-1} = 1023$$

Since $S = a\frac{(1-r^n)}{1-r}$ $\therefore S = \frac{a}{1-r} - \frac{ar^n}{1-r}$.

Now **when r is a proper fraction,** whether positive or negative, the absolute value of r^n will decrease as n increases, and the value of r^n may be made as small as we please by sufficiently increasing n.

Hence *when r is numerically less than unity,* the sum of the series may be made to differ from $\frac{a}{1-r}$ by as small a quantity as we please by making n sufficiently large, i.e. by taking a sufficiently large number of terms.

Thus the sum of an **infinite number** of terms of the G. P. $a + ar + ar^2 + \ldots\ldots$ in which r is *numerically less than unity,* is $\frac{a}{1-r}$; for $\frac{ar^n}{1-r}$ vanishes when n is infinitely great.

The student will realise what the above means, if he considers the series $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \ldots\ldots$

However many terms we add we never get up to the sum 2, though we approach more and more closely to 2 as we add more and more terms.

If we find the sum to infinity of the above series whose common ratio is $\frac{1}{2}$ by the above formula, we find $S_\infty = \frac{a}{1-r} = \frac{1}{1-\frac{1}{2}} = 2$.

Example:—

Find the sum to infinity of the series $\frac{1}{2}, -\frac{1}{4}, \frac{1}{8}\ldots\ldots$

$$S_\infty = \frac{a}{1-r} = \frac{\frac{1}{2}}{1-(-\frac{1}{2})} = \frac{\frac{1}{2}}{\frac{3}{2}} = \frac{1}{3}$$

Recurring decimals furnish a good illustration of a G. P. summed to infinity.

Find the value of $\cdot 3\dot{7}\dot{8}$.

$$\cdot 3\dot{7}\dot{8} = \frac{3}{10} + \frac{78}{1000} + \frac{78}{100000} + \ldots\ldots$$
$$= \frac{3}{10} + \frac{78}{10^3} + \frac{78}{10^5} + \ldots\ldots$$
$$= \frac{3}{10} + \frac{78}{10^3}\left(\frac{1}{10^2} + \frac{1}{10^4} + \ldots\ldots\right)$$
$$= \frac{3}{10} + \frac{78}{10^3} \times \frac{1}{1-\frac{1}{10^2}} = \frac{3}{10} \times \frac{78}{10^3} \times \frac{100}{99} = \frac{3}{10} + \frac{78}{990} = \frac{375}{990}.$$

Exercise 31

1. Find the 17th and 54th terms in the series 10, $11\frac{1}{2}$, 13 ……

2. Find the 13th and 20th terms in the series $-3, -2, -1$……

3. If the 6th term of an A. P. be 7 and the 11th term 13, find the first term and the nth terms.

4. The first term of an A. P. is 3, and the sum of 20 terms is 155; find the common difference.

Key to Exercise 28

(1) $-2 + 2i$. (2) $-16 + 36i$. (3) $\frac{147}{229} + \frac{72}{229}i$. (5) $x^4 - 4x^2 + 16 = 0$.

M. A. L.

GEOMETRY.—XIX

Proposition 124. Theorem

If a point move so that the tangents drawn from it to two fixed circles are always equal, its locus is a straight line.

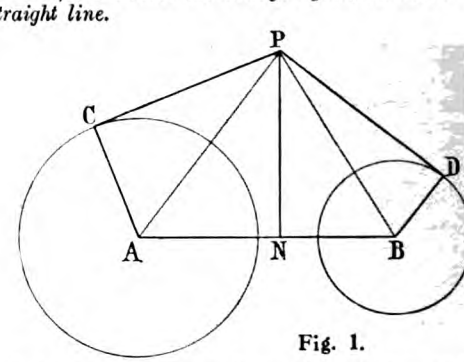


Fig. 1.

Let there be two circles with centres A and B, either not meeting (Fig. 1) or intersecting (Fig. 2).

Let P be a pt. on the locus, and let the tangents P C, P D be drawn.

It is required to prove that the locus of P is a straight line.

Proof.—Join A B. Draw P N $\perp$ to A B. (Prop. 22)

In Fig. 1 join P A, P B.

P C^2 = P D^2

Then $\because$ $\angle$s at C and D are rt. $\angle$s

$\therefore$ P A^2 — A C^2 = P B^2 — B D^2

$\therefore$ P A^2 — P B^2 = A C^2 — B D^2

but as the ○s are fixed $\therefore$ the radii are fixed and

$\therefore$ A C^2 — B D^2 = a constant, say K

$\therefore$ P A^2 — P B^2 = K.

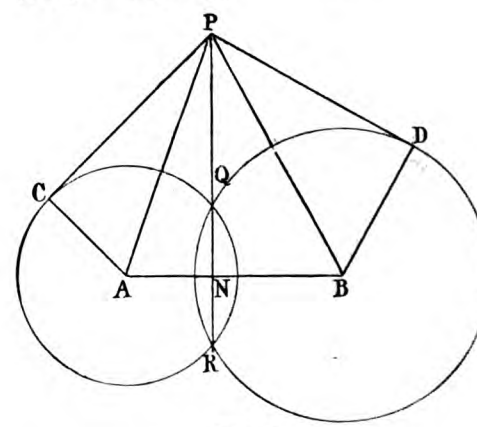


Fig. 2.

Now $\angle$ at N is a rt. $\angle$

$\therefore$ P A^2 — P B^2 = (A N^2 + P N^2) — (B N^2 + P N^2)
= A N^2 — B N^2
= (AN + B N) (A N — B N)

$\therefore$ (A N + B N) (A N — B N) = K

but A N + B N = A B = constant

$\therefore$ A N — B N is constant

$\therefore$ N is a fixed pt.

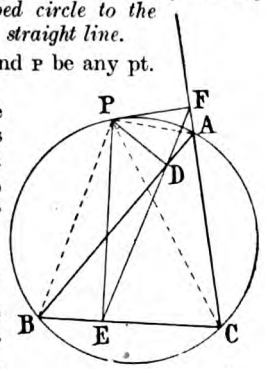
$\therefore$ the locus of P is a str. line $\perp$ to A B.

In Fig. 2 the locus of P is the common secant P Q R, for P C^2 = P Q, P R = P D^2 (Prop. 122).

Definition.—The locus of a point from which equal tangents can be drawn to two circles is called their **radical axis.**

Proposition 125. Theorem

The feet of the perpendiculars drawn from any point on the circumscribed circle to the sides of a triangle lie in a straight line.



Let A B C be any △ and P be any pt. on the circumscribed ○.

Let P D, P E, P F be ⊥s from P on the sides A B, B C, C A of the △ A B C.

It is required to prove that E, D and F are collinear.

Proof.—Join P A, P B, P C.

∠s P F A and P D A are rt. ∠s ∴ P F A D is a cyclic quadl. (Prop. 69).

Again ○ on P B as diameter passes through D and E

(∵ ∠s P D B, P E B are rt. ∠s)

∴ ∠ P D F = ∠ P A F (∠s in same segt.) (Prop. 66)

= supplement of ∠ P A C

= ∠ P B C (∵ P A C B a cyclic quadl.) (Prop. 67)

= supplement of ∠ P D E

(∵ P D E B is a cyclic quadl.) (Prop. 67)

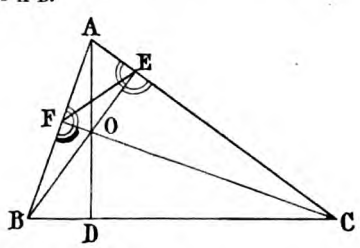
∴ F D, D E are in a str. line (Prop. 2).

This str. line is sometimes known as Grierson's Line.

Additional Theorem G

The perpendiculars from the vertices of a triangle on opposite sides are concurrent.

Let A B C be any △ and let B E be ⊥ to A C and C F ⊥ to A B.



Let B E, C F meet at O.

Join A O and produce it to cut B C at D.

It is required to prove that A D is ⊥ to B C.

Proof. Join F E.

∠ A E O = 1 rt. ∠ and ∠ A F O = 1 rt. ∠

∴ A E O F is a cyclic quadl. (Prop. 69)

∴ ∠ A E F = ∠ A O F (∠s in same segt.) (Prop. 66).

∠ A O F = ∠ C O D (vertically opp.) (Prop. 3)

∴ ∠ A E F = ∠ C O D.

○ described on B C as diameter passes through E and F

(∴ ∠s B E C and C F B are rt. ∠s).

∴ ∠ B C F = ∠ B E F (∠s in same segt.) (Prop. 66)

∴ ∠ A E F + ∠ B E F = ∠ C O D + ∠ B C F.

Now ∠ A E F + ∠ B E F = 1 rt. ∠

∴ ∠ C O D + ∠ B C F = 1 rt. ∠

i.e. ∠ C O D + ∠ D C O = 1 rt. ∠

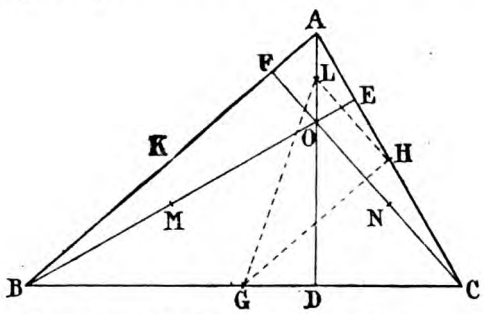
∴ ∠ O D C = 1 rt. ∠.

The point O is called the **orthocentre** of the triangle.

The Line Point Circle

In any triangle the feet of the perpendiculars from the vertices to the sides, the middle points of the sides of the triangle, and the middle points of the lines joining the vertices to the orthocentre all lie on a circle.

Let A B C be a △, and A D, B E, C F ⊥s to the sides, O the orthocentre and L, M, N the mid pts. of A O B O, C O and G, H, K the mid pts. of B C, C A, A B respectively.



It is required to prove that pts. D, E, F, G, H, K, L, M, N lie on a ○

Proof.—Join G L, G H, H L.

L and H are mid pts. of A O and A C respectively

∴ L H is ‖ to O C (Prop. 45).

G and H are mid pts. of B C, C A respectively

∴ G H is ‖ to B A (Prop. 45)

but O C is ⊥ to B A (hypothesis)

∴ L H is ⊥ to G H

∴ ⊙ described on G L as diameter passes through H (Prop. 70).

Similarly it may be shown that it passes through K.

It also passes through D ∵ ∠ L D G is a rt. ∠

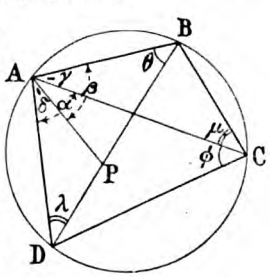
∴ ⊙ passing through G, H and K also passes through D and L.

Similarly it may be shown that this ○ passes through E and M and also through F and N.

Proposition 126. Theorem

The rectangle contained by the diagonals of a cyclic quadrilateral is equal to the sum of the rectangles contained by the pairs of opposite sides.

Let A B C D be a cyclic quadrilateral.



It is required to prove that rect. A C, B D = rect. A B, C D together with rect. B C, A D.

Proof.—At A in str. line D A make ∠ δ = ∠ γ (Prop. 18).

Let the line thus drawn cut B D at P.

$\left.\begin{array}{l}\alpha = \angle \text{D A C} = \delta + \angle \text{P A C} \\ \beta = \angle \text{P A B} = \angle \text{P A C} + \gamma\end{array}\right\} \therefore \alpha = \beta.$

In △s A D P, A C B

$\delta = \gamma$

$\lambda = \mu$ (∠s in same segment) (Prop. 66)

∴ △s are similar.

$\therefore \frac{A D}{D P} = \frac{A C}{B C}$ (Prop. 108)

∴ rect. A D, B C = rect. D P, A C.

In △s D C A, P B A

$\alpha = \beta$

$\theta = \varphi$ (∠s in same segment) (Prop. 66)

∴ △s similar.

$\therefore \frac{A C}{D C} = \frac{A B}{B P}$ (Prop. 108)

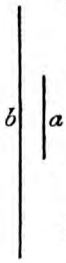
∴ rect. A B, D C = rect. A C, B P.

∴ rect. A D, B C + rect. A B, C D = rect. D P, A C, + rect. B P, A C

= rect. A C (D P + B P)

= rect. A C, B D.

The above is known as Ptolemy's Theorem.

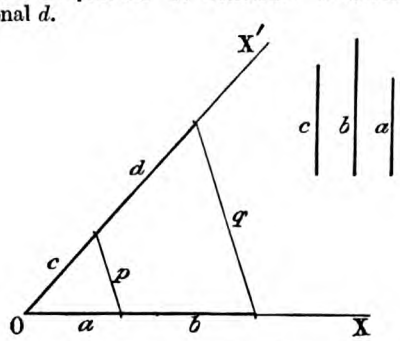


Proposition 127.—Problem

To construct a fourth proportional to three given straight lines.

Let *a b c* be three given str. lines.

It is required to construct a fourth proportional *d*.



i.e. to find *d* such that $\frac{a}{b} = \frac{c}{d}$.

Through any point O draw any two convenient str. lines O X, O X′.

Along O X mark off two lengths *a* and *b*.

Along O X′ mark off a length *c*.

Draw *p* joining the extremities of *c* and *a*.

Through the far end of *b* draw a line *q* ∥ to *p* cutting off a length *d* along O X′.

Then *d* is the required line, for $\frac{a}{b} = \frac{c}{d}$ (Prop. 102)

Proposition 128.—Problem

To construct a third proportional to two given straight lines.

This is a particular case of Prop. 127.

Given *a* and *b* to find a line *d* such that $\frac{a}{b} = \frac{b}{d}$.

All we need do is to make $b = c$ in above prop.

Proposition 129.—Problem

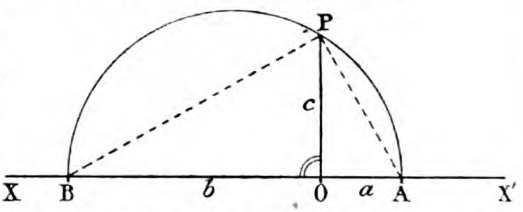
To construct a mean proportional between two given straight lines.

Let *a b* be the given str. lines. **It is required** to construct a line *c* such that $\frac{a}{c} = \frac{c}{b}$.

Take any convenient line X X′ and take a pt. O in it.

From O X′ cut off O A = *a* and from O X cut off O B = *b*.

On A B as diameter describe a semi ○.



Draw O P ⊥ to A P to meet the semi ○ in P.

Then C is the required line,

or $\frac{a}{c} = \frac{c}{b}$ (Prop. 112).

Proposition 130.—Problem

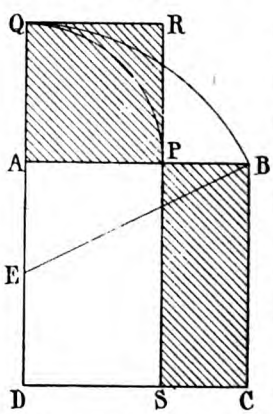
To divide a given straight line into two parts such that the rectangle contained by the whole and one part may be equal to the square on the other part.

Let A B be the given str. line.

It is required to find a pt. P in A B such that rect. A B . B P = A P^2.

On A B describe the sq. A B C D.

Bisect A D at E.



With centre E and radius E B describe a ○ cutting E A produced in Q.

With centre A and radius A Q describe a ○ cutting A B in P.

Then P is required pt.

Through P draw P S ∥ to A D and through Q draw a line Q R ∥ to A B cutting S P produced in R.

Then P C is a rectangle and Q P is a square.

A D is bisected at E and produced to Q

∴ rect. D Q . Q A = E Q^2 − E A^2 (Prop. 96).

But Q A = Q R and E Q = E B

∴ rect. D Q . Q R = E B^2 − E A^2

i.e. Fig. Q S = E B^2 − E A^2.

Now E A B is a right-angled △

∴ E B^2 = E A^2 + A B^2

∴ Fig. Q S = E A^2 + A B^2 − E A^2

= A B^2

= Fig. A C.

Take away Fig. A S which is common to both, then Fig. Q P = Fig. P C

i.e. A P^2 = rect. A B . B P.

Proposition 131.—Problem

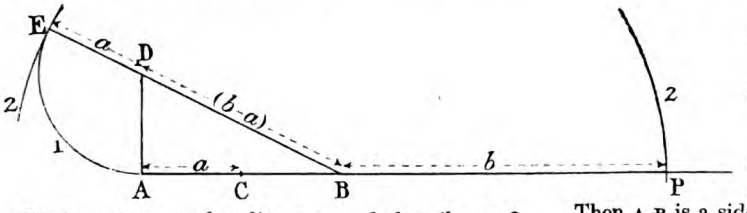
To find a point in a straight line produced, such that the square on the part produced is equal to the rectangle contained by the original line and the whole line thus produced.

Let A B be the str. line.

It is required to find a pt. P in A B produced such that B P^2 = rect. A B . A P.

Bisect A B at C. From A draw a line ⊥ to A B and cut off A D = A C.

With centre D and radius D A = A C = a describe ○ 1 cutting B D produced in E.



With centre B and radius B E = b describe ○ 2 cutting B A produced in P.

Then P is required pt.

∠ D A B = rt. ∠

∴ B D^2 = D A^2 + A B^2

i.e. $(b - a)^2 = a^2 + (2a)^2 = a^2 + 4a^2$.

But $(b - a)^2 = b^2 - 2ab + a^2$ (Prop. 95)

∴ $b^2 - 2ab + a^2 = a^2 + 4a^2$

∴ $b^2 - 2ab = 4a^2$

∴ $b^2 = 4a^2 + 2ab$

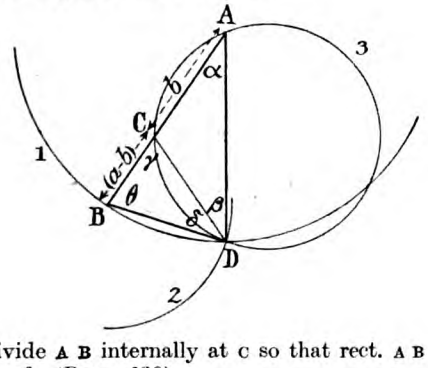
$= 2a\,(2a + b)$

i.e. B P^2 = rect. A B . A P.

Proposition 132.—Problem

To describe an isosceles triangle having each of the angles at the base double of the angle at the vertex.

Take any str. line A B . = a.



Divide A B internally at C so that rect. A B . B C = A C^2 (Prop. 130)

i.e. $a\,(a - b) = b^2$.

With centre A and radius = A B = a describe ○ 1.

With centre B and radius = A C = b describe ○ 2 cutting ○ 1 at D.

Join A D, B D. Then A B D is required △.

Join C D and circumscribe ○ 3 about △ A C D (Prop. 78)

Rect. A B . B C = A C^2 = B D^2

∴ B D is a tangent to ○ 3 (Prop. 123)

∴ $\delta = \alpha$ (Prop. 76)

exterior ∠ $\gamma = \alpha + \beta$ (Prop. 4, Cor. 3)

$= \delta + \beta$

$= \angle$ A D B

$= \theta$ (∵ A B D isos.).

But since $\gamma = \theta$ ∴ B D = C D (Prop. 7)

∴ C A = C D

∴ $\beta = \alpha$ (Prop. 6)

i.e. $\beta = \alpha = \delta$.

Now ∠ A D B = $\beta + \delta = 2\alpha$

∴ also $\theta = \angle$ A B D = 2α.

Proposition 133.—Problem

To construct a regular decagon in a circle.

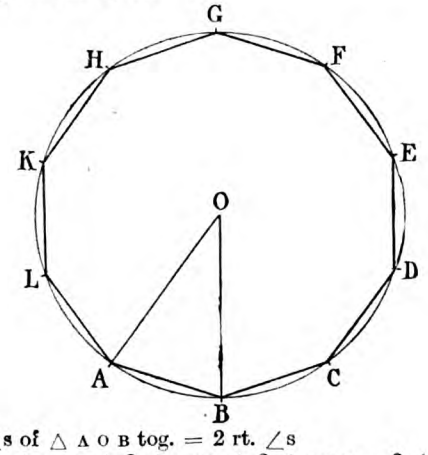
Let the given ○ have centre O.

Draw any radius O A.

Describe the isos. △ O A B such that each of the ∠s O A B, O B A = 2 ∠ A O B (Prop. 132).

Then A B is a side of the decagon.

Mark off chords equal to A B all round the ○ to complete the figure.



∠s of △ A O B tog. = 2 rt. ∠s

∴ ∠ A O B + 2 ∠ A O B + 2 ∠ A O B = 2 rt. ∠s

i.e. 5 ∠ A O B = 180°

∴ ∠ A O B = 36° = $\frac{1}{10}$ of a complete revolution

i.e. ∠ A O B is the ∠ subtended at the centre by the side of a regular decagon inscribed in the ⊙

∴ A B C D E F G H K L is required decagon.

Exercise 22

(1) A B C D is a cyclic quadrilateral such that B A, C D (produced) intersect at an angle of 30° and D A, C B (produced) intersect at an angle of 40°. Find the angles of the quadrilateral.

If the points A D coincide so that the quadrilateral becomes a triangle, what lines are they which intersect at 40° and what are the angles of the triangle? Construct this triangle, explaining your method.

(2) A, B, P, Q are four points in a plane; P and Q are on the same side of the straight line A B, and the angle A P B is equal to the angle A Q B. Prove that a circle can be described passing through the four points.

(3) Two straight lines A O B, C O D making with each other an angle of constant magnitude, turn about a fixed point O within a circle and intercept arcs A C, B D on the circumference. Prove that the sum of the arcs is constant.

(4) From a point 8 centimetres distant from the centre of a circle of 5 centimetres radius, tangents are drawn. Calculate the length of the chord of contact. (The chord of contact is the chord joining the points of contact of the tangents.)

(5) A circle touches the sides B C, C A, A B of a triangle A B C at the points D, E, F respectively; prove that 2 B D = B C − C A + A B. M. A. L.

Drawn by F. Matania.

WAGNER'S *RING OF THE NIBELUNGEN* AT COVENT GARDEN.

Brunnhilde is condemned to sleep upon a rock until the man who knows no fear shall force his way through the flames and awaken her. Siegfried appears, and his way is barred by Wotan; but Siegfried laughs at the terrors which the ancient god puts before him. He sounds a joyous note upon his horn and plunges into the flames. A moment later the shining hero is standing beside the sleeping Valkyrie.—(*Act III.*)

Continued from page 305.

ART AND MUSIC:

Contributors:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

MUSIC.—VI

WHILST the succession of sounds which we call a musical scale is the foundation and material of ordered melody, so in the nature of music, two melodies, or successions of notes, sung or played together, are the foundation of harmony. That two musical notes of different pitch, related in simple mathematical ratios, such as fifths, fourths, and thirds, sounding together, produced a pleasant sensation on the ear, was an early discovery.

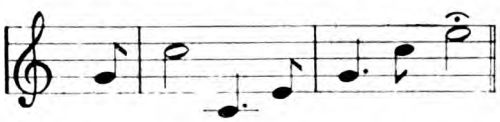
Indeed, this discovery was obliged, sooner or later, to be made; for, as we have already learned, harmony is inherent in Nature and Music. Just as daylight is produced by a combination of colours which merge into each other, resolving themselves into a pure light which appears to have no colour at all, so a single musical sound, when it is scientifically split up, is found to consist of a number of other tones, all blending together into one clear note.

Harmonics

These other tones are known as harmonics, or overtones. Ancient organ-builders, probably unaware of any natural law of acoustics, had found out the above fact, and by adding smaller pipes to reinforce or strengthen the harmonic octaves, fifths and thirds of certain principal big pipes, made very loud-sounding instruments. The system is scientifically applied to-day, in all organs, in the sets of pipes which are known as "mixture."

In tubular brass instruments—the notes depending on the length of the air-current—these harmonics can be made by proper blowing to sound as loudly as the fundamental note of the instrument. They are heard in bugle calls, and in the "open notes" of trumpets, trombones, cornets, horns, etc., and are used in their proper places as notes in the scale. A fine instance of the use of the natural succession of notes in the harmonic chord comes to mind in the Siegfried "Sword Motive" in Wagner's *Ring of the Nibelungen.* This motive is initially heard near the end of the *Rhinegold* (the first of the four operas), just as Wotan is thinking of a forthcoming race of demi-gods destined, as he dreams, to conquer the Nibelungs:—

Siegfried's Sword Motive



In stringed instruments played with a bow, the harmonics are made to sound by lightly touching the string (instead of pressing it on to the finger-board) at what are known as the "nodes"—those practically invisible and scarcely realisable points or depressions in a fiddle-string when vibrated. To make the proper sounds requires the utmost delicacy and certainty of finger and bow.

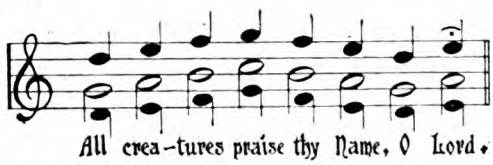
We can get an idea of these "nodes" by a little experiment. If you lay a rope of some twenty or thirty feet in length, stretched out on the ground, and jerk it from one end, you will see the wave of impulse making billows and leaving depressions along the whole length of the rope.

If the jerks given are sharp or smart enough and skilfully applied, the rope will billow rhythmically; and the far end, if it is heavily knotted, will suddenly rear and double back—like a snake bending its head to its tail—and will come undulating to hand. It is a trick familiar to many country boys who have to use cart and waggon ropes.

This example is a presentation on a large scale of what happens to a fiddle-string;

but as the end of the fiddle string attached to the peg cannot move, the "billows" are checked at the ridge at the top of the neck, and run back to the bridge, producing additional nodes to those which are made in going up.

The famous violinist Paganini (born 1784, Genoa; died 1840, Nice) was undoubtedly the first to master the practical side of these elusive "nodes," and to bring them under sufficient control to produce a complete harmonic scale. It was really a very wonderful thing to have accomplished, and one can well imagine how excessively puzzled unscientific players of his day must have been.



But even Paganini's discoveries were only on the surface. It was the work of earnest scientific modern investigators to fathom the philosophy of these wonderful things. Helmholz (died 1894), a German rector of the University of Berlin, led the way in this.

The earliest method of making vocal harmony which reached the dignity of being regarded and chronicled as a system, consisted in accompanying the true melody by notes rising or falling with it at a distance of a fifth above or a fourth below or both. The fourth below is an inverted fifth, or a fifth upside down, as you will see by counting the notes on the piano—C to G upwards, C to G downwards—the G's being octaves of each other.

The musical harmony of the Church of the period when Charlemagne's sons reigned in Europe, and Alfred the Great in England, was something like the example shown above, though the piece of music, of course, is not strictly historical.

The open notes represent the melody.

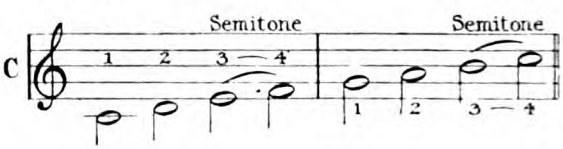
Such music appears very elementary, as indeed it is; and one may well wonder why, with all the notes of the scale at their command, and a knowledge of certain facts as to the physical construction of sounds, our monkish musicians had not progressed farther. Research has supplied a basis of explanation.

We are so accustomed to think of our scale of Doh to doh′ as the natural progenitor of music—as the foundation, in fact—that we are likely not to have given a thought to the possibility of a different arrangement of notes. But at one time the succession of intervals—intervals slightly different from the present ones, as we know—was marked off in groups of four, called "tetrachords" (Cf. *tettara*, four), and thus the foundation note of every tetrachord would be a fifth above the one below. Therefore, if a melody, made out of the notes of one set of four, were imitated in its rise and fall in the next tetrachord, the harmony would be in fifths; and if the lower octave to this were added, it would be in fourths.

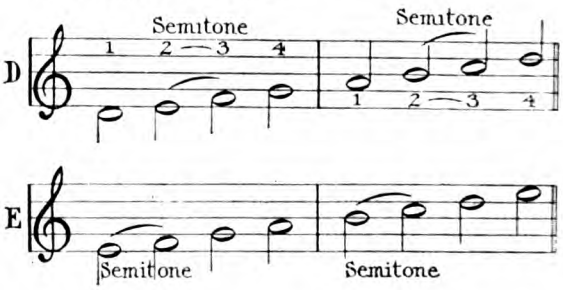
The hymn example shown above demonstrates this clearly: so that even this very elementary harmony had a philosophical basis.

Before progress is made in anything, you must experiment and proceed onwards from what you know.

If the following notes are played over, the idea of the "tetrachord" will be thoroughly apprehended:—



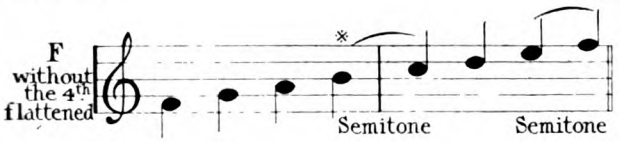
The scale of C is here shown divided into two equal portions, the half-tones coming in the same position in each tetrachord. Starting also from the scale of D the semitones fall into similar places in each tetrachord as below:—



The scale of E is similarly divided into two equal parts between the note A and the note B.

The semitones E, F, and B, C do not occur in the same position relative to the scale of C or D. But they do come in the same position, namely the first, in each tetrachord of the scale of E; this is clearly shown in the representations of the three scales, C, D, E in the above figures.

When we come, however, to the scale starting from the note F, we encounter a difficulty in regard to the position of the semitones.



The "half-notes," you see, do not fall properly, and the correct ecclesiastical Organum, as this monkish harmony was called, was impossible. But the means to overcome this were already in being. The fourth note of the first tetrachord was let down a semitone, making it the equivalent of our B♭, and thus rendering possible not only equal tetrachords in the scale of F, but also in G and A. (*See example below, next column.*)

It will be observed that without the employment of any more semitones, there were now two scales, C and F, which had a "leading note" to the octave—a seventh from the fundamental note—an inharmonious interval, which seems to seek rest on the note above; and it was clearly owing to this quality of the "seventh" and the gradual introduction of the interval of the third into harmony, that we owe our present highly-developed and wonderful system. Music, however, had a struggle of some centuries to emancipate itself from the formality of what were known as the Modes, about which we shall learn something later.

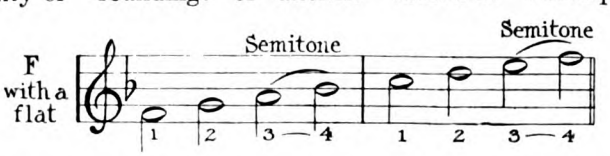
The fact may here be mentioned that it is from the circle which in early days marked the B flat (or B rotundum), and from the little square which indicated the B natural, that there have developed our signs for flat and natural—♭, ♮.

Another point to remember is that from C to B♭ in the scale of C, or the similar interval (a minor seventh) from any other fundamental note, is one of the sounds in natural harmony. It can be blown as an harmonic note—though a little out of tune to our ears—by an expert player on a tubular brass instrument, as an open note.

From the drawing by Maclise, in the South Kensington Museum.

PAGANINI (1784–1840), the famous violinist who was the first to produce a really complete harmonic scale on the violin.

To return to our illustration of ancient ecclesiastical harmony. Crude as the example on p. 368 may look upon paper, and hollow—bodiless—as it may sound to ears accustomed to the rich, full harmonies of modern music, the passage, if you can get it sung, and duplicated, even on an harmonium, an octave lower, will be found to have a quite "churchy" effect. And one may imagine a choir of monks, combined with the voices of their youthful pupils, assisted by the organs, trumpets, and pipes of the day, and maybe other instruments. Such music, in the surroundings of ancient cathedral worship which was very solemn and pompous, may have sounded to the ears of the people of that age wonderfully affecting and reverential, however crude and simple it may sound to a modern ear.



H. G.

Continued from page 312.

BUSINESS AND COMMERCE:

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke. CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—XX

THE complete specifications of an invention upon lodgment at the Patent Office are officially examined, and it is ascertained that the forms have been correctly filled in and that the specification compares accurately with that of the provisional application. After that the official examiner is called upon to satisfy himself that the invention does not clash with anything patented in this country within the previous fifty years.

Assuming, however, that the examining officer approves of and accepts the specification, it is placed in the Patent Office that it may be publicly examined, and official copies of both the specification and drawings may be purchased by the man-in-the-street at the standard price of 8s. each. The specification is also advertised publicly; and for a period of two months the invention is laid open to the world to challenge opposition, so that anyone with a prior claim or with a patent infringed by the new invention may come forward and make his protest.

Fourteen Years Monopoly

Such opposition, if any, is heard by an officer at the Patent Office, who goes fully into the matter and in due time makes his decision known.

Assuming, however, that no opposition is made the patent may be sealed upon payment of the sealing fee of £1 and thereafter, so long as the patentee (the person owning the patent) keeps up the payments specified in our last lesson he may safely regard the patent as his own for the period of fourteen years, and in certain exceptional cases even this period may be extended.

But to secure a patent in this country it is not always necessary to have invented something. Patents are readily granted to persons who introduce some useful idea from abroad, though they must state the person abroad from whom they have received the idea. Thus, articles already in common use in other countries but not protected by patent here may be introduced upon the same terms as a completely new invention.

It must naturally happen at times that two or more inventors will come upon precisely the same idea and wish to benefit from their ingenuity. In such cases it is the inventor who first secures a patent or provisional patent to whom protection is given, and the man who first applies is taken to be the inventor. A workman in the employ of a firm or individual may strike upon an idea in the course of his work that leads eventually to a profitable invention. In such a case the patent would at law belong to the workman.

Protection Abroad

As another case, however, it may be imagined that an inventor engages a mechanic to assist him in the perfecting of a model or in the execution of an idea, and as the work progresses the mechanic obtains an idea that suggests a vital improvement. In such a case the invention would be the property of the employer.

Patents are granted quite indiscriminately to men and women of British birth, and also to those who are foreigners; a patent is valid in the United Kingdom and in the Isle of Man but *not* in the Channel Islands.

It should be noted that in many instances it is advisable to register inventions in other countries besides one's own, but in the carrying out of these details a patent agent, with representatives in other capitals, would be of the first importance.

But apart from mechanical devices and other inventions that fall in the ordinary course of events under the jurisdiction of the Patent Office it is possible also to register a design. All sorts of novel devices that can hardly be termed inventions may be classed as designs, the shapes and outlines for certain much-used articles, the form of

appliances and tools. It would be quite conceivable, for example, to adapt a lamp so that it contained all the points of the average, everyday lamp and yet presented some unique novelty of design, shape or idea. In the ordinary way, such a lamp could not be patented and the inventor, to secure profit from his ingenuity, should have recourse to the Designs Act.

Under the provisions of this Act a designer may register his design for an initial period of five years, and for two further periods of five years each, the three periods, of course, to run consecutively. Very much the same terms and conditions apply to patents and to designs, and a patent agent would be able efficiently to attend to either class of business.

Trade Marks

Trade marks come in much the same category, and though at law there is no actual property in a trade mark, proceedings may be taken successfully to deal with people who fraudulently infringe a recognised trade mark. Invented words used to describe certain articles of commerce come under the heading of trade marks, and so do signatures, distinctive signs or symbols.

All trade marks should be registered at the Patent Office, London, and the method of procedure is very much the same as when taking out a patent, or when registering a design.

First of all the applicant obtains from the Patent Office an official form upon which he makes his application, the form being accompanied by numerous representations of the actual trade mark it is desired to register, and a description of the goods with which it is concerned. The particular mark is then advertised and in other ways publicly exhibited for a period of two months, during which opposition may be made to it by anyone interested in the mark, or whose rights the mark infringes in any way.

After this period the mark will be officially registered, subject to the prescribed fees being paid, and the first period of registration is for fourteen years, though the registration may be renewed for a further period of fourteen years after the lapse of the first period. In any case, as with patents and designs, it is better always to employ a registered patent agent to attend to the routine of having a trade mark officially protected and registered.

Copyright to a large extent comes within the scope of this Lesson, for the object of the law of copyright is to give to an author, composer, artist, designer or dramatist certain rights over his work so that others may not forge the works or otherwise benefit fraudulently from the issue or publication of those works.

The law of copyright applies equally to literary compositions, poetry, drawings and paintings, musical and dramatic works, and aims to prevent the publication or duplication of the works without the authority of the producer; so far as the individual producer is concerned copyright may be said, broadly speaking, to last for his lifetime and for a period of fifty years after his death. At the same time, after twenty-five years have passed it is legal for a person to publish works, provided due notice is given to the author or to his successors in the rights and certain fees are paid.

Naturally, an author may dispose of his copyright at once and this is usually done in the case of contributions to periodical publications and with many books, musical compositions, drawings, photographs and so on. Then, when the work is published, the actual copyright belongs to the person who bought it from the producer, in most instances the publisher himself.

Author's Copyright

There is no system of registration for copyright, broadly speaking. Publication ensures automatic copyright, for copies of all books, magazines and other publications have to be lodged at the British Museum, the Bodleian Library, Oxford, and certain other libraries, according to the nature of the work.

The copyright law applies to the United Kingdom and to many British possessions. It does not apply to the United States of America, however, and the only way to ensure copyright in that country of a work published in the United Kingdom is to arrange for simultaneous publication; so exacting is this law that a work published on a Saturday in England but on the Sunday following in America would not be copyrighted in the latter country. As a matter of fact, the work of copyrighting matter both here and in the United States is usually left to a literary agent with a representative in Washington or New York.

So that with patents, designs, trade marks and copyright there is, subject to compliance with the various Acts, protection for the original producer, at all events for a specified number of years; and it behoves the alert business man to understand the many ramifications of the system. A. B.

CHOOSING A CAREER.—XXII

The Law.—As a profession, the Law may be divided into two sections: the barristers and the solicitors. The sections are quite separate; and though occasionally for professional reasons solicitors do become barristers they have first to cease to be solicitors.

Briefly, the work of the **barrister** is to advise and to appear in court to conduct cases that are to be heard before a judge or judges. Barristers may plead in any court; but usually their efforts are confined to the higher courts. Barristers are consulted in their chambers upon difficult points of law by solicitors; but the initial work of a case is conducted entirely by the solicitor, who presents the details, particulars of witnesses and such information in the form of a "brief"; and the barrister goes into court and handles the case upon the knowledge conveyed by this document.

Of the two professions—and the student should realise that they are quite distinct—that of the barrister is the more precarious; but, at the same time, in many circumstances the Bar leads to higher points, and our most successful barristers probably earn more than leading solicitors. There are, however, more barristers who earn practically nothing than there are solicitors.

It goes without saying that the candidates for honours at the Bar should be possessed of considerable personal means. The cost of the necessary education and training is very considerable, and several years must inevitably pass before a young barrister can hope to make his practice remunerative. Education at a university (Oxford or Cambridge for preference) is of the greatest assistance to the would-be barrister.

The Middle and Inner Temples, Lincoln's Inn and Gray's Inn are the four Inns of Court, through one of which the candidates must pass. They form as it were a kind of legal training ground; and there are four terms, Hilary, Easter, Trinity and Michaelmas. Twelve terms constitute the period of studentship, and the student must dine in the Hall of his Inn for a given number of nights during each term.

Throughout these terms the work of study, reading, and preparation proceeds; and eventually there comes the Bar Examination, the way to which will have been paved by lectures; and in some circumstances the student will obtain practical experience by "reading" with a Counsel. The examination is purely confined to legal subjects, common law, criminal law, property law, legal history and similar matters; and when the student has passed this test he may be "called to the Bar."

The cost will probably have totalled to about £150; and much more in cases where students have "read" with Counsel. But it should be explained that prizes and scholarships can be gained at the Inns.

Many barristers in the early days of their career take up one particular line of legal work and become specialists in that department. Some make a speciality of divorce cases, others confine their activities to trade disputes, and others, again, to criminal cases.

The Bar, moreover, may be said to lead to a great variety of high legal appointments, and judges, stipendiary magistrates (those who receive stipends, in contradistinction to the voluntary magistrate or Justice of the Peace), recorders, coroners and other public officers are to a great extent recruited from the ranks of the barristers.

For the barrister who practises, however, an influence with solicitors will, of course, be of the utmost importance. King's Counsel are barristers who are said to have "taken silk," and confine themselves mostly to the giving of opinions and to actual court work at fees higher than those of the average barrister. There are heavy charges to be paid on attaining to this honour.

In Ireland there is of course a separate Bar, though the conditions of being called are very much the same as those pertaining in England. Irish barristers are called through King's Inn, Dublin. In Scotland a barrister is known as an advocate, and a special knowledge of Scots law is essential. The ruling body through whom the examinations are conducted is known as the Faculty of Advocates, with headquarters at Edinburgh.

The work of a **solicitor** is totally different from that of the barrister. In the case of litigation it is the solicitor who sees the clients, interviews witnesses, and prepares the evidence and statements; and, quite apart from court work of any kind, there is that important section of legal practice, the conveyancing of land and property.

Wills, probate, company business, corporation and council work, marriage settlements, and a host of other matters, all come within the range of a solicitor's activities, so that when once established in a good practice there should be little idleness.

Altogether, there are three examinations to be passed by those who wish to become solicitors. There is the preliminary, the

intermediate and the final ; though university graduates and others of proven education are in some circumstances excused the first. The examinations, which are held in several provincial cities as well as in London, are conducted by the *Law Society, Chancery Lane, London, W.C.*1, and the fee for the preliminary is £4.

When the candidate has successfully passed the first examination he may obtain his articles of clerkship ; or, in other words, become an articled clerk or pupil ; and he must remain in articles usually for a period of five years. The stamp duty to be paid upon the documents that record the articling of a clerk is £80 ; and the articles have to be registered with the Law Society.

It is only natural that a solicitor should make considerable charge for taking a youth and teaching him the rudiments of his profession.

There are some solicitors, indeed, who will not take less than £300 for articles of clerkship ; though there are others who will accept £100, or even less. Occasionally articled clerks are paid a small wage ; and in every case they have to begin more or less at the bottom of the ladder, and learn office and legal routine from the very commencement.

The intermediate examination may be said to apply to clerks who are half-way through their articles ; and this test is also held by the Law Society. The subjects embrace the laws of England, trust accounts and similar professional matters, and the articled clerk during his first two or three years of employment will devote at least a part of his leisure to the study of legal books in preparation for this exam. In due course the final examination follows, and it should be mentioned that from time to time studentships are offered, particulars of which are obtainable by writing to the Law Society.

When the student has passed the final examination he is called upon to pay further sums for stamp duty, and fees amounting to about £30 ; and in due time his name will be entered on the Roll of Solicitors.

But when all these steps have been taken he may not, even then, practise until he has taken out a licence, costing from £3 to £4 10s. a year for the first three years, but doubled for the years that follow.

In many instances young solicitors buy a partnership with an established firm ; and there are but few newly-qualified practitioners who immediately start to practise independently. Some young men may have sufficient connections locally to be able to venture with some hope of success on an independent practice.

On the other hand, there are many public appointments that are to be obtained by solicitors, including town clerkships, clerkships to the guardians, magistrates' clerkships, taxing masterships, and so on.

So far as Scotland is concerned, there are Writers to the Signet, solicitors who practise in the high courts of that country and who, after passing their indentures or apprenticeship, are registered at the *Signet Office, Edinburgh,* from whom the latest information may be obtained, though a course at a Scottish university is usually insisted upon by the authorities.

Law Agents in Scotland are the solicitors who practise in the lower courts ; and students are called upon to attend law lectures, to pay certain fees, and to pass the test of the *Board of Examiners for Law Agents, Edinburgh,* from whom particulars may be obtained.

In Ireland the procedure is not unlike that of England ; except that the Incorporated Law Society undertakes the examinations and registers the successful candidates. The offices of this Society are in Dublin.

Notaries are closely connected with the legal profession and act as official witnesses to various documents. To become a notary a candidate must serve as an articled clerk in a notary's office, and eventually pay certain fees for registration at the *Faculty Office, London, E.C.* **Commissioners for Oaths** are chosen from the ranks of solicitors ; and a solicitor who wishes to become a commissioner must apply to the Lord Chancellor.

Reference to our special lessons on the subject of municipal employment (*Vol. II., p.* 437), will show how a young man starting in the Clerk's office of a county, borough, city, urban or rural council may eventually become a qualified solicitor ; and there are countless lawyers who have attained to high honours after only a secondary education. A university education is by no means a necessity, though, of course, it is an excellent training ground for this profession.

At the same time, every solicitor must be a keen lawyer, well versed in his art. He must also be a man of the world, discreet, sympathetic, businesslike and imaginative. Certainly no branch of the profession should be entered upon lightly and without patient forethought ; and there is reason to believe that the ranks of our lawyers are to some extent overcrowded. A. C. M.

BOOK-KEEPING.—XVI

Partnership Accounts (*Continued*)

In order to make the personal accounts of a partnership more clearly understood, we will take a specific case. W. Spencer and Arnold Matthews are in business for a particular year, and each brings in to the business a capital of £2,500. The Capital Accounts will be as follows :—

Dr. W. SPENCER'S CAPITAL ACCOUNT *Cr.*

		£	s.	d.
Jan. 1	By Cash	2,500	–	–

Dr. ARNOLD MATTHEWS' CAPITAL ACCOUNT *Cr.*

		£	s.	d.
Jan. 1	By Cash	2,500	–	–

During the year Spencer withdraws £200 for private purposes, and Matthews £250. Their Drawing Accounts will appear thus :—

Dr. W. SPENCER'S DRAWING ACCOUNT *Cr*

		£	s.	d.
To Cash		200	–	–

Dr. ARNOLD MATTHEWS' DRAWING ACCOUNT *Cr.*

		£	s.	d.
To Cash		250	–	–

Suppose that during the year the Partnership business made a profit of £450. This would mean that Spencer and Matthews would each have of this profit the sum of £225. The Profit and Loss Account would therefore appear somewhat as follows :—

The treatment of the Balance Sheet, however, is a matter which depends entirely upon the nature of the partners' capital. Now, according to some Partnership Articles, it is an express condition that the amount of capital of each partner must be fixed and unalterable, so that if any drawings are made from capital, or any profit is realised or loss sustained, the Capital Account must not be disturbed in any way, but the deductions from or additions to the business must be shown in separate Current or Drawing Accounts.

In other cases the capital will vary with any deductions from or additions to it, so that at the end of a particular year it will be different from what it appeared at the beginning.

The following will illustrate our meaning.

Dr PROFIT AND LOSS ACCOUNT *Cr.*

	£	s.	d.		£	s.	d.
To General Expenses ..	100			By Gross Profit (transferred from trading a/c)	700		
„ Office Salaries	100						
„ Rent	50						
„ Net Profit:							
W. Spencer £225 ..							
A. Matthews £225 ..	450						
	700				700		

The left hand column shows the liabilities side of a Balance Sheet with the capitals fixed, whilst the right hand column shows the liabilities with the capital alterable.

Liabilities side of Balance Sheet.

(A) *Fixed Capital Method.*

Bills Payable			£220 –
Creditors			900 –
W. Spencer's current a/c			
Add share of profit	225 –		
Add interest	115 –		
	340		
Less drawings	200 –		
		140 –	
Arnold Matthews' current a/c			
Add share of profit	225 –		
Add interest	112 10		
	337 10		
Less drawings	250 –		
		87 10	
Capital a/cs			
W. Spencer		2,500 –	
A. Matthews		2,500 –	
		£6,347 10	

(B) *Alterable Capital Method.*

Bills Payable			£220 –
Creditors			90 –
W. Spencer's capital a/c	£2,500 –		
Add share of profit	225 –		
Add interest	115 –		
	2,840 –		
Less drawings	200 –		
		2,640	
Arnold Matthews' current a/c	2,500 –		
Add share of profit	225 –		
Add interest	112 10		
	2,837 10		
Less drawings	250 –		
		2,587 10	
		£6,347 10	

It will be seen from the above that in the Fixed Capital method all additions to or deductions from the partners' shares of the business must go to the Current Account because the capitals are unalterable ; whereas in the Alterable Capital method the various additions and deductions are recorded in the Capital Accounts. We recommend the latter method, as it is undoubtedly more in accordance with the true position, for as drawings are made from and amounts added to a partners' share, such must really affect his capital. The treatment is in practice decided by agreement between the partners themselves.

As we have already pointed out, apart from these special ways of treating the partners' own shares in the capital, and profits of a partnership, the keeping of the books of a partnership is the same as for a sole trader. It frequently happens, however, that persons who are in partnership take in another person as an additional partner.

Now it will be obvious to the student that when such is the case, the facts must receive special attention in the books of account, for at least one thing happens, namely, that the new partner brings something into the business. As a matter of fact, a new partner often brings in not only cash, but also goodwill, which is in effect a guarantee that he will contribute to the partnership some of his own business connections.

We will now illustrate the different ways of treating the admission of a new partner.

Case 1.—It is assumed that W. Spencer and Arnold Matthews (whose accounts have just been shown) have decided to receive K. Huxley as a partner provided he brings in a capital of £2,500, and that the goodwill (valued at £1,800) which he brings in be allowed to be credited to the old partners in equal proportions.

The receipt of the £2,500 will appear in the Cash Book thus :—

Dr. CASH BOOK *Cr.*

	£	s.	d.		£	s.	d.
To K. Huxley Capital Account	£2,500						

The £1,800 being an addition to goodwill is debited to Goodwill Account, and it has to be placed at the same time to the credit of the old partners' accounts. The Journal entry will therefore be as follows :—

Goodwill	£1,800 (*Dr.*)	
To W. Spencer (Capital a/c)		£900
„ Arnold Matthews (Capital a/c)		900

Case 2.—In this example we will suppose that when Huxley joined Spencer and

Matthews he not only put into the business a capital of £2,500, but paid to each of the partners a premium of £500.

The additions of the £2,500 capital will be entered in the Cash Book as in Case 1, but the premium, which is given to the old partners personally, is not entered in the partnership books at all.

Premium Receipts

Case 3.—Here it is presumed that Huxley brings in his £2,500, and that the additional premium of £1,000 which he is to pay to the partners in equal proportions has been paid to the firm and not to the individual partners. The Cash Book will therefore show the receipt of the premium, and afterwards its payment in equal proportions to the two partners thus :—

Dr. CASH BOOK *Cr.*

	£	s.	d.		£	s.	d.
To K. Huxley (c/a) ..	2,500	–	–	By W. Spencer (premium withdrawn)	500	–	–
,, W. Spencer (half of premium)	500	–	–	,, A. Matthews (premium withdrawn)	500	–	–
,, A. Matthews (half of premium)	500	–	–				

Finally, it should be noted that when a partner lends money to the partnership this should be credited to the partners' separate Loan Account. When a partner receives a special salary for acting in some particular managerial capacity, this should be charged to Profit and Loss Account, as it is a payment which the firm will have to make, quite irrespective of whether a profit is realised or not, although apart from agreement no partner may claim payment for services rendered to the partnership.

A Contract is the name given to an agreement which the law can enforce. This relationship occurs in all businesses ; practically every transaction recorded in books of account relates to some form of contract or agreement. When we refer to Contract Accounts, however, we mean the accounts of the business of a contractor, who undertakes to carry out certain specific work, generally in the building, engineering, or shipbuilding trades.

Although a contractor's business is complex, its account-keeping, if arranged on a systematic and well organised basis, should not present insuperable difficulties, especially to the student who clearly understands the practice followed when dealing with consignments and joint accounts.

Suppose that you are Samuel Bland, a builder and contractor, whose business it is to undertake various classes of builders' work, such as erection of new buildings, alterations and improvements to existing buildings, etc., and that you have just agreed to carry out four contracts, which are numbered and described as follows :—

Contract No. 150 (£10 000), erection of a Cotton Warehouse.

Contract No. 250 (£4,500), rebuilding of the Blue Bell Inn.

Contract No. 300 (£7,000), erection of additions to a residence.

Contract No. 350 (£3,000), reinstatement of a Cottage Hospital after damage by fire.

It would most probably happen that in each of these cases an architect would have furnished you with full particulars as to the labour and material required for the different contracts, and that you have given him your price for doing the work. Your tenders have been accepted, and you have signed what are called "contract agreements," which bind you (subject to certain conditions) to carry out the work in a stipulated time.

On the acceptance of the contracts, it would not be necessary for you to make any entry in your financial books, but it would be advisable to adopt some plan whereby a definite number can be allotted to each contract.

This is done by means of a Works Order Book, which we will consider next.

Definitions of Terms

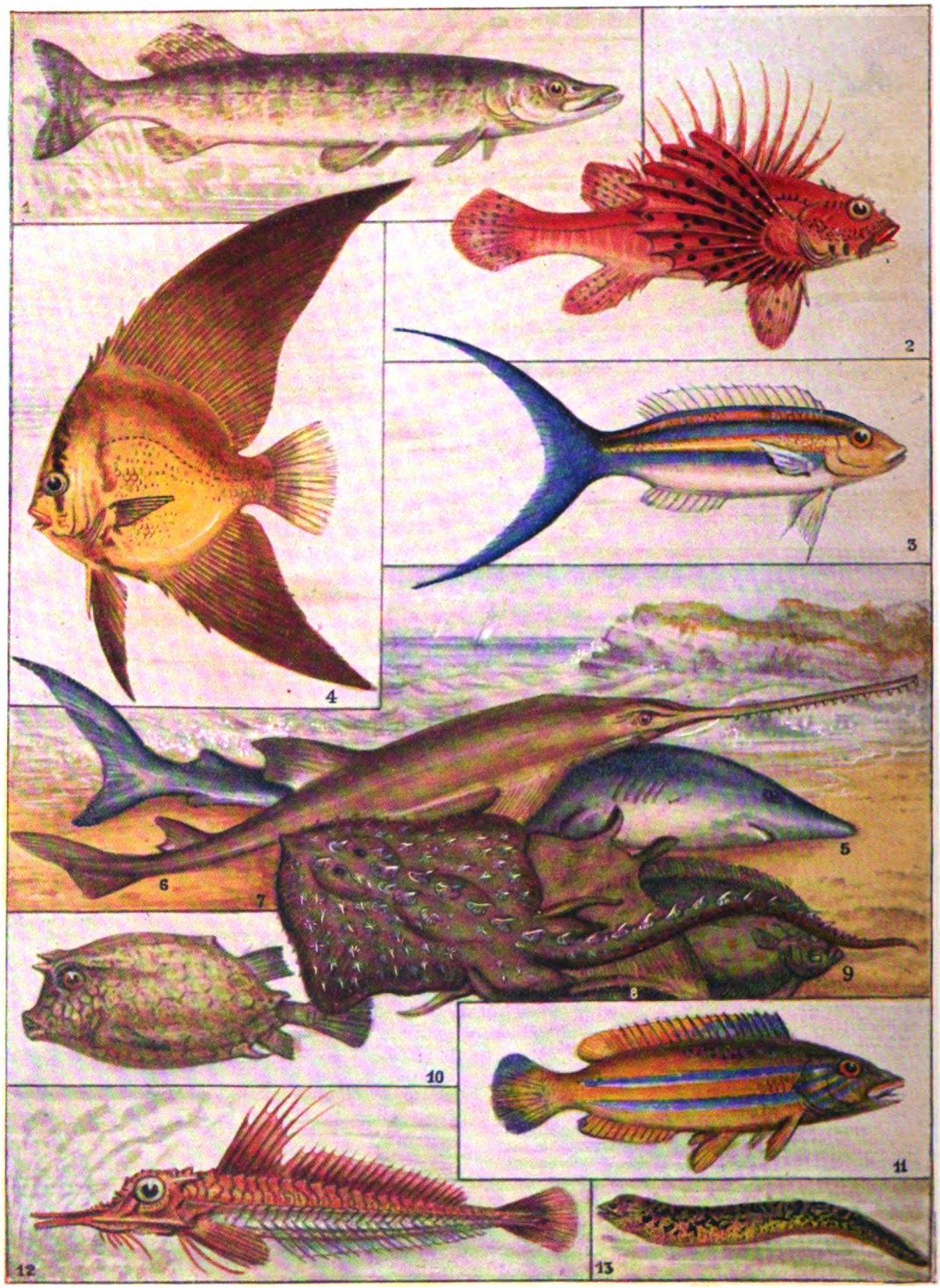
Bond.—This is a document under seal, by which a person binds himself or is bound to pay a certain sum of money in a stipulated time under certain conditions.

Bounty.—This is a bonus or grant given by a Government to manufacturers with a view to encouraging the production and exportation of certain classes of goods. It enables the exporter to meet the competition of foreign traders.

F. O. B. or Free on Board means that when a merchant sells goods all charges on them are paid by the seller before the goods are put on the ship, and the buyer only pays the price of the goods themselves plus any charges incurred on board.

C. O. D. or Cash on Delivery means that goods must be paid for when they are delivered.

F. H.



FISH.

1, Pike; 2, Great Red Fire-fish; 3, Blue Crescent-tail; 4, Leaf-moon Choetodon; 5, Blue Shark; 6, Saw Fish; 7, Starry Ray; 8, Ox Ray; 9, Plaice; 10, Trunk Fish; 11, Blue Striped Wrasse; 12, Mailed Gurnard; 13, Muræna.

Continued from page 322.

ENGLISH LANGUAGE AND LITERATURE:

Contributors:—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

PHILOSOPHY.—II

THE first and more fundamental problem of metaphysics is to ascertain the relationship between matter and mind, between the outer world of objects and the inner world of consciousness.

Materialism

Materialism claims to solve this problem in favour of matter. The first step in such an inquiry should be to state precisely what is understood by the terms matter and mind; but this is beyond our power. No one, philosopher or specialist, scientist or mystic, has yet succeeded in framing a passable definition of matter, and the meaning of mind is still more recondite. The definitions of matter that are commonly found in text-books of Physics either contain mutually contradictory statements, or, as in the example—" matter is that of which objects are composed "—are " full of sound " and " signify nothing."

In the absence, therefore, of an adequate definition, the modest teacher must content himself with a statement of the qualities, properties or attributes which are generally recognised as applying to all forms of matter.

In the first place, it has *extension*, which means that it occupies space. Then, it is *impenetrable*, i.e. two distinct portions of matter cannot occupy one and the same space. Thirdly, it *persists*, it is indestructible and cannot be created. To these fundamental properties may be added:—*inertia*, moving matter tends to retain its motion: *weight*, every particle of matter attracts every other particle and so they tend to approach one another: *porosity*, the structure of matter is not continuous but discrete.

It is not possible in this place to explain these properties more fully or to criticise them; but emphasis must be laid on the truth that matter is ever in motion, there is no such thing as absolute rest. A moving train has its own motion relatively to the earth, it has the earth's motions, on its axis and on its orbit round the sun: and the whole is moving with the entire solar system towards the constellation Hercules at the rate of half a million miles a day. Rest is therefore a relative term and does not exist in our experience. Further, " the fairy tales of Science " and " the long result of Time " leave no doubt that matter is always undergoing change, an impression of the world which literature fathers on the ancient Greek philosopher Heraclitus, who in his well-known saying παντα ρει—everything is in a state of flux, all is change—made a very happy guess at a great truth which was only firmly established many centuries later.

Ontological Assumptions

Those who have been able to acquire more than a passing knowledge of the properties of matter by studying physics, chemistry and physiology, and those who have caught even a transient glimpse into the operations of mind in the study of psychology will be in a better position to attack the ontological problem than those who are without such preliminary training.

Philosophy is always running up against ordinary, common-sense views, and although these have always to be duly considered, it is not uncommon to find them devoid of rational foundation. The fundamental assumption of ontology, that there is an inherent difference between matter and mind, between physical and psychical phenomena, is a case where the common-

sense view harmonises with that of many philosophers. The pin which pricks my finger is obviously very different from the pain which its entrance into my flesh evokes in my consciousness. The will which prompts me to crush a beetle is fundamentally dissimilar to the nerves which convey the murderous message to my muscles, to the latter which move my foot, and to the poor beast which suffers extinction. This assumption of the antithesis (opposed nature) of matter and mind will receive consideration in a later chapter. If it be found unwarranted the ontological problem disappears : for the present we will assume that it is in accordance with the facts and proceed to expound the claims of materialism.

Mind and Matter

Innumerable facts of everyday life testify to the close connection existing between matter and consciousness. Body acts on mind, and mind on body. The mental powers of a normal man are most active when his physical powers are at their best. The beneficial effects of repose, either in the form of sleep or of a good holiday, are particularly noticeable in the case of brain-workers ; and exhaustion or over-fatigue of body brings in its wake a corresponding slackness of the mental powers. The effects of anæsthetics, drugs, alcohol and the like upon our bodily organs are accompanied by characteristic changes in our mental states.

Every housewife knows that a good meal exercises " charms to soothe the savage breast " ; and appeals to our charitable instincts or to our artistic feelings are little likely to succeed when our stomachs are in need of food. Conversely, mind acts upon matter when on the receipt of good news our vital powers are stimulated. Emotions of pain, pleasure, love, hatred, etc., are faithfully reflected in our facial expressions and gestures.

Severe mental exertion induces physical fatigue. Food does us more good when our state of mind is a happy one, and generally, a happy environment conduces to good health and longevity. By the mere exercise of will-power, an athlete can increase his powers of endurance, and a sick person can hasten his convalescence. A hypochrondiac or a valetudinarian can so lower his powers of resistance that he falls an easy victim to disease. That part of the body which is pre-eminently associated with consciousness, the brain or central organ, develops and increases in weight *pari passu* with the mental development ; and the evidence of mental pathology proves that if this organ be injured, diseased or undergo degeneration, one or more of the mental powers will be correspondingly affected.

Lastly, the science of physiology has established beyond any rational doubt that all psychical processes are accompanied by physical and chemical changes in the brain and nervous system ; there are some changes in the latter which are not accompanied by consciousness, as in the so-called reflex actions, but there is no consciousness without some kind of cerebral disturbance.

So far, then, as our present knowledge extends we may take it as certain that all mental events are inseparably connected with material changes. Does the converse hold good ? Does matter exist irrespective of our consciousness ? The common-sense view is that it does. I see a stationary object before me. I close my eyes, and although I do not know, i.e., see it, I believe without a shadow of a doubt that it is still there. Does the teaching of science corroborate this inference ?

Priority in Time of Matter

The Science of Astronomy tells us that the physical conditions of at least the great majority of the heavenly bodies are absolutely inconsistent with the probability, nay the possibility, of conscious life *as we know it*.

According to this science and to geology, our own planet was in a similar state in the remote past, and both sciences predict without hesitation that in the distant future there will come a reversion to this lifeless state. From these data the materialist infers that matter is the primordial entity, the substrate, and that mind is an attribute of it in that stage of its history when the physical conditions are favourable to its existence and development.

If he be asked, how, when and why life and its ephemeral attribute, consciousness, originated, the materialist replies that his inability to give definite answers to these questions in no way affects the legitimacy of his thesis that mind does not exist apart from matter, and that matter does exist independently of mind in the world as we know it to-day. At the same time, although they cannot affirm it with any degree of certitude, most materialists believe that it is a necessary corollary of the law of evolution that living matter did develop from non-living matter and that consciousness was duly evolved as a property of it.

The doctrine of " soul " asserts that the psychical powers of man (and animals ?), or

a refined part of them, existed originally as a separate entity, entered into his body at some unknown stage of his development, dwells within him during his conscious life, and leaves it when he is asleep or when he dies, to wander into "fresh woods and pastures new."

The materialist points out that this theory throws no more light upon the mode of origin of life and consciousness than his own, and that it is at variance with the established fact that, at least in this world, mind does not exist unassociated with matter: "never matter, no mind," but not "never mind, no matter."

The prevalence of this primitive doctrine of the soul as a temporary lessee of the body he ascribes to the all-too-common malady of regarding the world through "the distorting medium of desire," of believing to be true what we wish to be true.

Animism

The theory or belief in the soul was part and parcel of a more general doctrine, called "animism," which involved the personification of nature. Not only were the sun, the winds, the waters, fire, thunder, etc., regarded as the manifestations or the seats of special in-dwelling spirits, but very often such objects as stones, tools, armour, houses and boats were animated in a similar manner.

Such projection of subjective (human) elements into the world of objects was man's earliest method of "explaining" the apparently hopeless medley of things and phenomena which surrounded him. Later, the multiplicity of spirits, ghosts, etc., was replaced by a unity, but for the most part the projected human attributes were still retained.

The fallacy of all such interpretations lies in the attempt to explain the unknown in terms of a still greater unknown, to prescribe as the cause of an unusual or mysterious occurrence something even more remote and undefined. This is the method of "supernaturalism." According to modern science, to "explain" an event is to correlate it, to connect it up, with something better known, and if possible to bring it under the scope of (subsume it under) some natural law, some general statement of fact, which sums up our experience of all similar phenomena.

By applying such generalisations to particular cases, science is enabled to fulfil her chief function—prediction. Thus it occasionally happens that the daylight begins to wane when the sun is still high in the heavens, animate nature is hushed, birds go to roost, flowers close their petals, the air becomes chilled, and ere long all is in darkness. The pall of night, however, gradually slips off and the "light that failed" re-asserts itself. We can imagine the effect that such a weird phenomenon produces upon the mind of untutored man, and can understand his attempt to "explain" it by saying that the orb of day was first swallowed and then disgorged by black cloud-monsters. As we all know, astronomy explains the occurrence by correlating it with the relative positions of sun, moon and earth; and from innumerable past observations of these heavenly bodies and from the laws which have been formulated to sum up their motions, she can predict to a second when such eclipses will recur and many of the details concerning them.

The question is, then: To what better known phenomena can the processes of mind be referred? Obviously not to other mental phenomena, for the reason stated above. According to materialism, the only alternative—assuming matter and mind to be the sole contents of reality—is to correlate them with material phenomena, with the changes that take place in the brains and nerves of sentient beings. Primitive materialism would probably have asserted that the sensation of pain in my injured finger is only another name for the movements and disturbances set up in my brain and nervous system.

Many later day materialists would admit the different nature of the sensation and the changes taking place in the nervous system, but they would content themselves with the correlation of the two phenomena, they would link them up in the same "chain of causation," and that is all the "explanation" they would attempt or admit to be possible.

Summary

It is not possible to define matter or mind.

The chief properties of matter are: extension, persistence, inertia, weight, impenetrability and porosity.

Nothing is at rest; all is in motion and undergoing change.

The common-sense view is often erroneous.

Ontology assumes an inherent unlikeness between matter and mind.

Materialism asserts: There is a constant interaction between matter and mind. Matter is independent of mind, but mental phenomena are always associated with material phenomena. Life and consciousness were most probably evolved from inanimate matter; the doctrine of "soul" is obsolete and unscientific.

Scientific explanation is description and correlation. The explanation of mental facts consists in correlating them with physical facts. E. H. T.

THE DAWN OF THE REFORMATION.

From the picture by W. F. Yeames, R.A.: by permission of Messrs. Henry Graves & Sons, Ltd.

The way was prepared for the great religious revolution, which swept over Britain in the sixteenth century, two centuries before that revolution occurred, by John Wycliffe (1324–84), who is shown above sending out his "poor priests" to make the Gospel known.

Continued from page 327.

HISTORY:

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BRITAIN'S STORY.—VIII

[*The introductory chapter to* LORD MACAULAY'S "*History of England*" *has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages* (*printed in closer type*) *have been interpolated in order to meet the requirements of the student.*]

THOSE who hold that the influence of the Church of Rome in the dark ages was, on the whole, beneficial to mankind may yet with perfect consistency regard the Reformation as an inestimable blessing.

The leading strings, which preserve and uphold the infant, would impede the full-grown man. And so the very means by which the human mind is, in one stage of its progress, supported and propelled, may, in another stage, be mere hindrances. The child who teachably and undoubtingly listens to the instructions of his elders is likely to improve rapidly. But the man who should receive with childlike docility every assertion and dogma uttered by another man no wiser than himself would become contemptible.

Church Government

It is the same with communities. The encroachments of the ecclesiastical power on the province of the civil power produced much more happiness than misery, while the ecclesiastical power was in the hands of the only class that had studied history, philosophy, and public law, and while the civil power was in the hands of men who could not read their own grants and edicts. But knowledge gradually spread among laymen. At the commencement of the sixteenth century many of them were in every intellectual attainment fully equal to the most enlightened of their spiritual pastors. Thenceforward that dominion, which, during the dark ages, had been, in spite of many abuses, a legitimate and salutary guardianship, became an unjust and noxious tyranny.

From the time when the barbarians overran the Western Empire to the time of the revival of letters, the influence of the Church of Rome had been generally favourable to science, to civilisation, and to good government. But, during subsequent centuries, to stunt the growth of the human mind has been her chief object.

Throughout Christendom, whatever advance has been made in knowledge, in freedom, in wealth, and in the arts of life, has been made in spite of her, and has everywhere been in inverse proportion to her power.

Catholic and Protestant

Whoever, knowing what Italy and Scotland naturally are, and what, four hundred years ago, they actually were, shall now compare the country round Rome with the country round Edinburgh, will be able to form some judgment as to the tendency of Papal domination. The descent of Spain, once the first among monarchies, to the lowest depths of degradation, the elevation of Holland, in spite of many natural disadvantages, teach the same lesson.

Whoever passes in Germany from a Roman Catholic to a Protestant principality, in Switzerland from a Roman Catholic to a Protestant canton, in Ireland from a Roman Catholic to a Protestant county, finds that he has passed from a lower to a higher grade of civilisation. On the other side of the Atlantic the same law prevails. The Protestants of the United States have left far behind them the Roman Catholics of Mexico, Peru, and Brazil.

The French have doubtless shown an energy and an intelligence which, even when misdirected, have justly entitled them to be called a great people. But this apparent exception, when examined, will be found to confirm the rule; for in no country that is called Roman Catholic has the Roman

Catholic Church, during several generations, possessed so little authority as in France.

The struggle between the old and the new theology in our country was long, and the event sometimes seemed doubtful. There were two extreme parties, prepared to act with violence or to suffer with stubborn resolution. Between them lay, during a considerable time, a middle party, which blended, very illogically, but by no means unnaturally, lessons learned in the nursery with the sermons of the modern evangelists, and, while clinging with fondness to old observances, yet detested abuses with which those observances were closely connected.

The Tudor Monarchy

Men in such a frame of mind were willing to obey, almost with thankfulness, the dictation of an able ruler who spared them the trouble of judging for themselves, and, raising a firm and commanding voice above the uproar of controversy, told them how to worship and what to believe. It is not strange, therefore, that the Tudors should have been able to exercise a great influence on ecclesiastical affairs; nor is it strange that their influence should, for the most part, have been exercised with a view to their own interest.

Henry the Eighth attempted to constitute an Anglican Church differing from the Roman Catholic Church on the point of the supremacy, and on that point alone. His success in this attempt was extraordinary. The force of his character, the singularly favourable situation in which he stood with respect to foreign powers, the immense wealth which the spoliation of the abbeys placed at his disposal, and the support of that class which still halted between two opinions, enabled him to bid defiance to both the extreme parties, to burn as heretics those who avowed the tenets of the Reformers, and to hang as traitors those who owned the authority of the Pope.

During the first twenty years of his reign, Henry VIII. was commonly regarded as a gay, pleasure-loving king, who, though full of ambitious schemes, was quite content to leave his own destiny, and that of the country, in the hands of Cardinal Wolsey.

Thus, although the hand of the Government was heavy on the people, and although the means employed to raise money were often harsh and arbitrary, Henry himself retained his popularity. The responsibility and odium of oppression fell almost entirely upon Wolsey; whilst the country, growing rich and prosperous under a strong government, looked with fervent loyalty to the king who stood before them as the preserver of the peace and welfare of the community.

But Henry had no male heir; and the want of one caused him considerable uneasiness, for, as he realised only too clearly, uncertainty about the succession to the throne must, sooner or later, plunge England again into a bloody conflict.

By his first wife, Catherine of Aragon, he had had several children, but all had died in infancy—with one exception, the Princess Mary; and after 1520 it seemed certain that Catherine, who was older than himself and sickly, would bear him no more children.

So long, however, as Henry remained in alliance with the Emperor Charles V., Catherine was useful to him politically. But in 1523 Henry's friendship with Charles began to cool. Two years later, it turned into open hostility; and Henry then found Catherine a distinct obstacle in the way of his new policy—namely, of friendship with France.

Catherine of Aragon originally had married Henry VII.'s eldest son, Prince Arthur. It was upon the latter's death in 1506 (see the genealogical table on page 385) that she was taken to wife by Henry VII.'s second son, who subsequently became Henry VIII.

Catherine of Aragon Divorced

Now there was sufficient irregularity in this marriage with his deceased brother's wife to provide Henry with a protest for the divorce which political considerations rendered desirable, and which became a determined object when the king fell in love with Anne Boleyn, a lady of Catherine's court.

Wolsey, being anxious to cement an alliance with France, at first favoured the divorce scheme. But when he found that it was being urged to make room for Anne Boleyn, his enthusiasm waned. None the less, in obedience to the king's wishes, he persevered with the project, despite the fact that it raised many awkward questions.

Foremost among those was the attitude adopted by the Pope who, terrified lest he should draw upon himself the wrath of Charles V., was reluctant to take any action in the matter. Eventually he consented to constitute Cardinals Wolsey and Compeggio as commissioners to inquire into the king's plea.

The legates sat in London in 1529. But the case ultimately was revoked to Rome, and, although every effort was made to outwit or override the opposition of Catherine, the unfortunate Queen stuck resolutely to her defence. This turned on the dispensation which had been specially granted by a previous Pope in order that Henry might marry her. The Pope, therefore, had no chance of evading the main issue; and Henry, in consequence, was left disappointed.

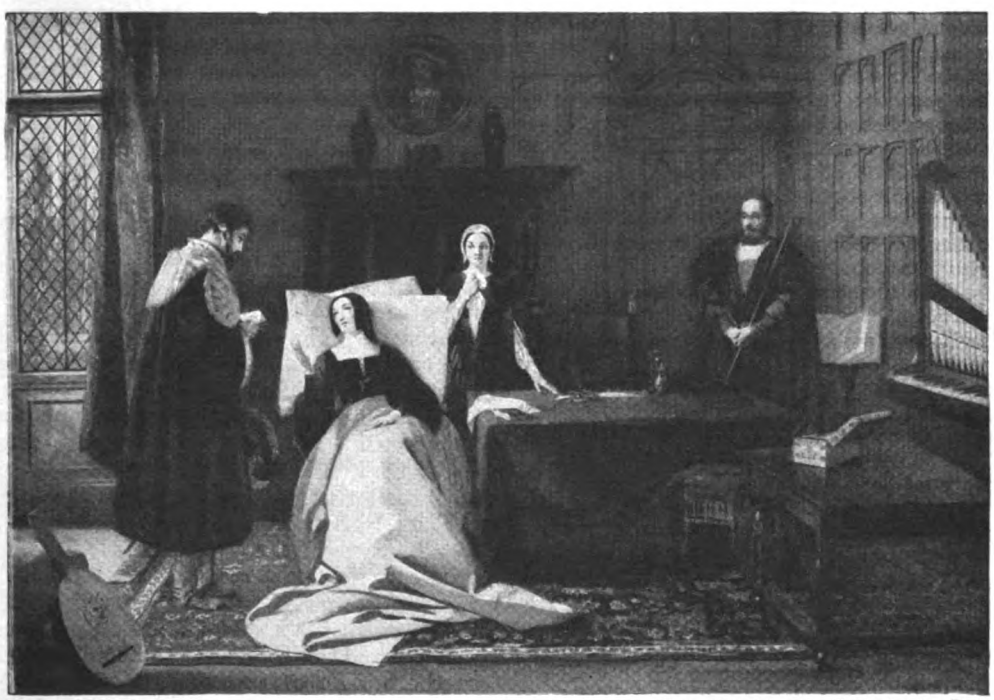
The immediate result of his disappointment was the downfall of Wolsey. The minister, who had so faithfully served his master that he had no other friend, was brought under the penalties of the Statute of Præmunire* for having exercised the office of papal legate; and having been found

* The Statute of Præmunire, first passed in 1353, in the reign of Edward III., forbade the King's subjects having dealings with Rome without the royal consent.

From the picture by Henry O'Neill, A.R.A.

TRIAL OF QUEEN CATHERINE.

A dramatic incident in the opening scenes of the great divorce case, heard at Blackfriars in May, 1529, was the Queen's pathetic appeal to her husband.



From the picture by C. R. Leslie, R.A.

THE DEATH OF QUEEN CATHERINE

occurred, as the result of a lingering illness, in January, 1536, at Kimbolton, in Huntingdonshire. The luckless ex-Queen was then in her fiftieth year.

guilty, was driven from office, expelled from court and deprived of all his enormous private fortune.

This occurred in 1529. In November, 1530, he died at Leicester, a broken-hearted man, while on his way from York to London to answer a preposterous charge of treason.

In the meanwhile, Henry, by dragging before the world the secrets of his domestic life, and showing openly his attachment to Anne Boleyn, had entered upon a career destined to have momentous consequences.

The Lutheran revolt in Germany had already done much to shake the foundation of the papal authority. Henry VIII., however, had shown his orthodoxy by writing against Luther, and, in return, had received from the Pope the title, "Defender of the Faith." But the demand for reform was still louder within the Church, and Henry, hoping thereby to influence the Pope to grant him the divorce which he desired, decided now to listen to it.

Henry VIII. and the Church

In 1529 he encouraged Parliament to pass measures checking various clerical abuses. Then he roused the apprehensions of the papacy by collecting opinions from all the leading universities of Europe upon the question of the Pope's power to legalise marriage with a brother's widow. In 1531 Henry went further, and threatened all the clergy of England with the penalties of Præmunire because they had recognised Wolsey's legative authority; and the clergy, though able to buy off the royal displeasure, were forced to give to the king the title of supreme head of the Church.

But the Pope still remained obdurate.

Next year, therefore, Parliament, encouraged by the king, continued the war against the clergy, and took steps to prevent the customary payment of annates, or first fruits, to the Pope.

But even this attack failed; and in 1533 the king, whose patience by this time had been exhausted, took the law into his own hands, and secretly married Anne Boleyn.

The Pope threatened to excommunicate Henry for this act.

Parliament replied by forbidding appeals to Rome.

The divorce question was then tried before the court of Archbishop Cranmer, and Catherine, who refused to plead, was pronounced contumacious, sentence being pronounced against her.

The Pope declared the divorce illegal.

Thus the breach between Henry VIII. and Rome was complete; and in 1534 Parliament finished the work by separating the Church of England from the papal control, and instituting it as a national church under the headship of the king.

Henry VIII.'s chief adviser in these measures was Thomas Cromwell, a statesman who had risen to notice in Wolsey's service. Cromwell wished to establish the royal power as supreme over Church and State alike, and he sternly repressed the discontent which his activities aroused. The monks of the Charterhouse perished on the scaffold for refusing to admit the royal supremacy. Sir Thomas More and Bishop Fisher were executed because they could not take oath that they conscientiously approved of Cromwell's changes.

In this way, discontent was cowed into acquiescence; whilst the royal supremacy, exercised by Cromwell as Vicar-General, was used for clearing away seed-plots of dissatisfaction. In 1536 the smaller monasteries were visited and suppressed. In 1539 the larger monasteries met with the same fate; and the lands of these institutions passed into the hands of a class of new nobility, who thus had a direct interest in maintaining the new state of things.

The abbots disappeared from the House of Lords. The Parliamentary influence of the Church came practically to an end. Indeed, there was no limit to the royal power, or to the subservience of Parliament; and Henry VIII. seems to have regarded himself as superior to all recognised principles of human conduct.

Yet, in matters ecclesiastical, he merely desired nothing more than the absorption into the Crown of the powers previously exercised by the Pope. But, having once severed England from Rome, he found it difficult to hold in check the influence of Lutheranism.

Bishops Hooper and Ridley

Henry's system, therefore, died with him. Had his life been prolonged, he would have found it difficult to maintain a position assailed with equal fury by all who were zealous either for the new or for the old opinions. The ministers who held the royal prerogatives in trust for his infant son, Edward VI., could not venture to persist in so hazardous a policy; nor could Elizabeth venture to return to it. It was necessary to make a choice. The government must either submit to Rome, or must obtain the aid of the Protestants.

The government and the Protestants had only one thing in common, hatred of the papal power. The English Reformers were eager to go as far as their brethren on the Continent. They unanimously condemned as anti-Christian numerous dogmas and practices to which Henry had stubbornly adhered, and which Elizabeth reluctantly abandoned. Many felt a strong repugnance to things indifferent which had formed part of the policy or ritual of the mystical Babylon.

Thus Bishop Hooper, who died manfully at Gloucester for his religion, long refused to wear the episcopal vestments. Bishop Ridley, a martyr of still greater renown, pulled down the ancient altars of his diocese, and ordered the Eucharist to be administered in the middle of churches, at tables which the Papists irreverently termed oyster boards. Bishop Ponet was of opinion that the word Bishop should be abandoned to the Papists, and that the chief officers of the purified church should be called Superintendents.

When it is considered that none of these prelates belonged to the extreme section of the Protestant party, it cannot be doubted that, if the general sense of that party had been followed, the work of reform would have been carried on as unsparingly in England as in Scotland.

But, as the government needed the support of the Protestants, so the Protestants needed the protection of the government. Much was therefore given up on both sides: an union was effected; and the fruit of that union was the Church of England.

To the peculiarities of this great institution, and to the strong passions which it has called forth in the minds both of friends and of enemies, are to be attributed many of the most important events which have, since the Reformation, taken place in our country; nor can the secular history of England be at all understood by us, unless we study it in constant connection with the history of her ecclesiastical polity.

The Anglican Church—

The man who took the chief part in settling the conditions of the alliance which produced the Anglican Church was Archbishop Cranmer.

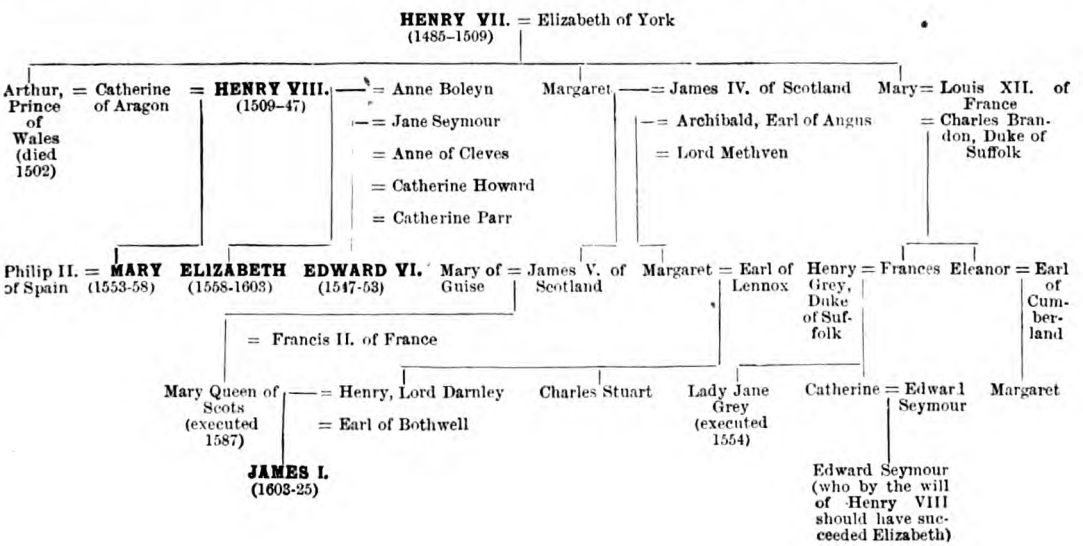
He was the representative of both the parties which, at that time, needed each other's assistance. He was at once a divine and a courtier. In his character of divine he was perfectly ready to go as far in the way of change as any Swiss or Scottish Reformer. In his character of courtier he was desirous to preserve that organisation which had, during many ages, admirably served the purposes of the Bishops of Rome, and might be expected now to serve equally well the purposes of the English Kings and of their ministers.

To this day the constitution, the doctrines, and the services of the Church retain the visible marks of the compromise from which she sprang. She occupies a middle position between the Churches of Rome and Geneva. Her doctrinal confessions and discourses, composed by Protestants, set forth principles of theology in which Calvin or Knox would have found scarcely a word to disapprove. Her prayers and thanksgivings, derived from the ancient Breviaries, are very generally such that Cardinal Fisher or Cardinal Pole might have heartily joined in them.

—Built on a Compromise

The Church of Rome held that episcopacy was of divine institution. A large body of Protestants, on the other hand, regarded prelacy as positively unlawful. The founders of the Anglican Church took a middle course. They retained episcopacy; but they did not declare it to be an institution essential to the welfare of a Christian society.

Among the Presbyterians the conduct of public worship is, to a great extent, left to the minister. Their prayers, therefore, are not exactly the same in any two assemblies on the same day, or on any two days in the same assembly. The priests of the Roman Catholic Church, on the other hand, have, during many generations, daily chanted the same ancient confessions, supplications, and thanksgivings, in India and Lithuania, in Ireland and Peru. The service, being in a dead language, is intelligible only to the learned; and the great majority of the



congregation may be said to assist as spectators rather than as auditors. Here, again, the Church of England took a middle course. She copied the Roman Catholic forms of prayer, but translated them into the vulgar tongue, and invited the illiterate multitude to join its voice to that of the minister.

In every part of her system the same policy may be traced. Nothing, however, so strongly distinguished the Church of England from other Churches as the relation in which she stood to the monarchy.

The King was her head, but the limits of the authority which he possessed, as such, were never traced with precision. The laws which declared him supreme in ecclesiastical matters were drawn rudely and in general terms.

Church and State

That the King was, under Christ, sole head of the Church, was a doctrine which the founders of the English Church all with one voice affirmed: but those words had very different significations in different mouths, and in the same mouth at different conjunctures. Sometimes an authority which would have satisfied Hildebrand was ascribed to the sovereign: then it dwindled down to an authority little more than that which had been claimed by many ancient English princes who had been in constant communion with the Church of Rome.

What Henry and his favourite counsellors meant, at one time, by the supremacy, was certainly nothing less than the whole power of the keys. The King was to be the Pope of his kingdom, the vicar of God, the expositor of Catholic verity, the channel of sacramental graces. He arrogated to himself the right of deciding dogmatically what was orthodox doctrine and what was heresy, of drawing up and imposing confessions of faith, and of giving religious instruction to his people. He proclaimed that all jurisdiction, spiritual as well as temporal, was derived from him alone, and that it was in his power to confer episcopal authority, and to take it away.

According to this system, as expounded by Cranmer, the King was the spiritual as well as the temporal chief of the nation. In both capacities His Highness must have lieutenants. As he appointed civil officers to keep his seal, to collect his revenues, and to dispense justice in his name, so he appointed divines of various ranks to preach the gospel and to administer the sacraments. It was unnecessary that there should be any imposition of hands.

The King—such was the opinion of Cranmer given in the plainest words—might, in virtue of authority derived from God, make a priest; and the priest so made needed no ordination whatever. These opinions the Archbishop, in spite of the opposition of less courtly divines, followed out to every legitimate consequence. He held that his own spiritual functions, like the secular functions of the Chancellor and Treasurer, were at once determined by a demise of the crown.

When Henry died, therefore, the Primate and his suffragans took out fresh commissions, empowering them to ordain and to govern the Church till the new sovereign should think fit to order otherwise.

These high pretensions gave scandal to Protestants as well as to Catholics; and the scandal was greatly increased when the supremacy, which Mary had resigned back to the Pope, was again annexed to the crown, on the accession of Elizabeth. It seemed monstrous that a woman should be the chief bishop of a Church in which an apostle had forbidden her even to let her voice be heard.

The Queen, therefore, found it necessary expressly to disclaim that sacerdotal character which her father had assumed, and which, according to Cranmer, had been inseparately joined, by divine ordinance, to the regal function. When the Anglican confession of faith was revised in her reign, the supremacy was explained in a manner somewhat different from that which had been fashionable at the court of Henry.

By Divine Right

Cranmer had declared, in emphatic terms, that God had immediately committed to Christian princes the whole cure of all their subjects, as well concerning the administration of God's word for the cure of souls, as concerning the administration of things political. The thirty-seventh article of religion, framed under Elizabeth, declares, in terms as emphatic, that the ministering of God's word does not belong to princes.

The Queen, however, still had over the Church a visitatorial power of vast and undefined extent. She was entrusted by Parliament with the office of restraining and punishing heresy and every sort of ecclesiastical abuse, and was permitted to delegate her authority to commissioners. The Bishops were little more than her ministers.

Rather than grant to the civil magistrate the absolute power of nominating spiritual pastors, the Church of Rome, in the eleventh century, set all Europe on fire. Rather than grant to the civil magistrate the absolute

From the picture by Sir John Gilbert, R.A.

HENRY VIII. AND CARDINAL WOLSEY,

the great minister who steered the ship of State during the first twenty years of Henry's reign. Born in 1475 (?) of humble parentage at Ipswich, Wolsey rose by sheer force of his capacity until in 1514 he became Archbishop of York, and in 1515 a Cardinal, Chancellor of England, and, probably, the most powerful and influential man in Europe.

power of nominating spiritual pastors, the ministers of the Church of Scotland, in more recent times, resigned their livings by hundreds. The Church of England had no such scruples. By the royal authority alone her prelates were appointed. By the royal authority alone her Convocations were summoned, regulated, prorogued, and dissolved. Without the royal sanction her canons had no force.

One of the articles of her faith was that without the royal consent no ecclesiastical council could lawfully assemble. From all her judicatures an appeal lay, in the last resort, to the sovereign, even when the question was whether an opinion ought to be accounted heretical.

Temporal Power

Nor did the Church grudge this extensive power to our princes. By them she had been called into existence, nursed through a feeble infancy, guarded from Papists on one side and from Puritans on the other, protected against Parliaments which bore her no good will, and avenged on literary assailants whom she found it hard to answer. Thus gratitude, hope, fear, common attachments, common enmities, bound her to the throne. All her traditions, all her tastes, were monarchical. Loyalty became a point of professional honour among her clergy, the peculiar badge which distinguished them at once from Calvinists and from Papists.

Both the Calvinists and the Papists regarded with extreme jealousy the encroachments of the temporal power on the domain of the spiritual power.

Difficulties of the Establishment

The advantages which the crown derived from this close alliance with the Established Church were great; but they were not without serious drawbacks. The compromise arranged by Cranmer had from the first been considered by a large body of Protestants as a scheme for serving two masters, as an attempt to unite the worship of the Lord with the worship of Baal.

In the days of Edward the Sixth the scruples of this party had repeatedly thrown great difficulties in the way of the government. When Elizabeth came to the throne, those difficulties were much increased.

Violence naturally engenders violence. The spirit of Protestantism was therefore far fiercer and more intolerant after the cruelties of Mary than before them.

From the picture by F. Goodall, R.A., in the South Kensington Museum.

CRANMER AT TRAITORS' GATE.

Henry VIII.'s great Archbishop won for himself the especial enmity of Queen Mary on account of the active part he played in the divorce proceedings of her mother, Catherine of Aragon, and on account of his support of Lady Jane Grey. Soon after Mary's accession he was thrown into the Tower of London (*via* Traitors' Gate: *vide* above), and in 1554 was charged with heresy, being burnt to death in front of Balliol College, Oxford, in March, 1556.

Continued from page 341.

SCIENCES:

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CHEMISTRY.—XXIII

Carbon Dioxide.—CARBON dioxide is a colourless gas that is always present in the air to the extent of from 3-4 volumes in 10,000, and vitiated air may contain as much as ten times this amount. Small as these quantities may appear, its presence is of extreme importance to man, since without it there would be no vegetation and no animal life.

This gas is produced mainly by the respiration of higher organisms and of plants at night time, but it also gets into the atmosphere as a result of fermentation and putrefaction, from volcanoes and other subterranean sources. The amount normally present in the air does not vary greatly, as it is ever being removed by the chlorophyll of plants, by the solvent action of natural waters and by the "weathering" of rocks and minerals. It is usually made in the laboratory by the action of hydrochloric acid upon marble, but it must be noted that almost any other acid could be used and also any other carbonate. $CaCO_3 + 2HCl = CO_2 + H_2O + CaCl_2$.

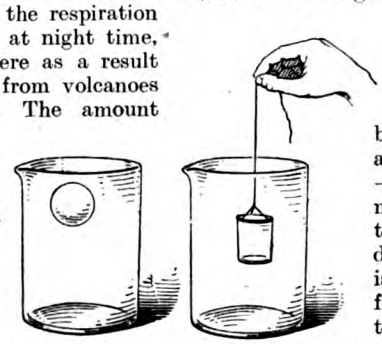


Fig. 38.—To show the density of carbon dioxide : a soap bubble will float in the gas; by means of a small beaker suspended by a string the gas may be removed from a larger beaker like water from a well.

Experiment LXXI. — *To prepare and examine carbon dioxide.*

(i) Small lumps of marble are introduced (sideways) into the apparatus used for making hydrogen, and then covered with water. Concentrated hydrochloric acid is then poured in through the funnel and the escaping gas is collected over water. The very slight taste having been noted, (ii) the behaviour towards a flame should be examined, and then (iii) experiments should be performed to see if it is lighter or heavier than air (see if it can be poured upwards or downwards). (iv) To find out if it dissolves in water, a test tube is half filled with the gas and half with water and the open end under water closed tightly with the thumb. The tube is removed and well shaken. On reopening under water, the latter is observed to rise appreciably. The resulting solution may be tasted and its action on litmus determined. (v) The gas is passed into clear lime-water for about five minutes (vi) The air exhaled from the lungs is shaken up with some of the same reagent. (vii) A strip of magnesium ribbon is ignited and lowered into a jar of the gas. When the reaction is over, the white solid may be separated from the black specks by treatment with hydrochloric acid and filtering.

Accurate experimenting shows that carbon dioxide has a slightly acid taste, and that it neither burns nor supports combustion. That magnesium burns in it is due to the fact that the gas is decomposed by the heat, the metal then combines with the liberated oxygen and the carbon is set free. $2Mg + CO_2 = 2MgO + C$. The gas is much heavier than air, and is therefore usually collected by downward displacement; and it is appreciably soluble in water, forming an acid solution which turns litmus a pale claret colour.

Some striking additional experiments may be performed to illustrate its density, etc. A large soap bubble will float on the gas contained in a large beaker; and the gas may be taken out from the beaker by means of a small beaker suspended on a string, like water from a well. The gas may also be siphoned or poured out from one vessel into another, its presence in the second vessel being detected with a light or with lime-water. If some turpentine or petroleum be ignited in a dish, and a large beaker of the gas be inverted over it, the flame is at once extinguished. Carbon dioxide is much used in fire-extinguishers.

Under ordinary conditions, water dissolves about its own volume of carbon dioxide, and this fact is of very great importance in nature, and is utilised by man for preparing effervescing drinks. By increasing the pressure, much more gas can be dis-

solved, in fact the weight of gas dissolved is directly proportional to the pressure (Henry's Law). Soda-water is water charged with carbon dioxide under high pressure, to which a very little bicarbonate and sulphate of sodium are usually added. When the excess pressure is removed by opening the bottle, the excess of gas escapes. Champagne, lemonade, beer, etc., behave similarly.

The greater part of the gas contained dissolved in pure water is in a state of physical solution, but a portion of it combines with the liquid to form carbonic acid, a very weak acid which is decomposed when the solution is warmed or if the pressure upon it be reduced. $CO_2 + H_2O \rightleftarrows H_2CO_3$. It should be noted that the dry, pure gas has no acid properties: the name "carbonic acid gas" is therefore a misnomer.

The large quantities of carbon dioxide evolved in the manufacture of beer were formerly always allowed to escape, but are now often collected, liquefied (30·8 atmospheres at -5°), and sent into commerce in steel cylinders. Such liquefied carbon dioxide is not used in the manufacture of mineral waters because it imparts a slightly unpleasant taste to them, but it is very useful as a refrigerant. When liquid carbon dioxide is allowed to evaporate quickly, as e.g. by passing it through a canvas bag attached to the nozzle of the inverted cylinder, so much heat is absorbed that some of it freezes to a white solid like snow. This "carbonic acid snow" is used by surgeons as a local anæsthetic in removing moles, birth-marks and other skin blemishes.

Fig. 39. — To find the percentage of carbon dioxide in a carbonate.

Carbonates. — Carbonic acid is dibasic and forms two series of salts with bases, viz. normal carbonates and bicarbonates, e.g. normal sodium carbonate, Na_2CO_3, sodium bicarbonate, $NaHCO_3$, normal calcium carbonate $CaCO_3$, calcium bicarbonate, $Ca(HCO_3)_2$. The carbonates and bicarbonates of sodium, potassium, and ammonium are water soluble; the normal carbonates of calcium, magnesium and most other metals are practically insoluble, but the bicarbonates, where they exist, are soluble.

Soluble carbonates can be prepared by the action of carbon dioxide upon alkalis (NaOH, KOH, NH_4OH). If carbon dioxide be passed into caustic soda solution until no more is absorbed, sodium bicarbonate is left in solution, $NaOH + CO_2 = NaHCO_3$. By adding an equivalent amount of the alkali to the solution, the normal carbonate results, $NaHCO_3 + NaOH = Na_2CO_3 + H_2O$. On crystallising, washing soda, $Na_2CO_3,10H_2O$ separates. Carbon dioxide is often absorbed in sodium hydroxide, which, being in excess, causes the formation of normal carbonate, $2NaOH + CO_2 = Na_2CO_3 + H_2O$. The carbonates of potassium and ammonium may be prepared in like manner. The soluble normal carbonates are unaffected by heat, except in so far as water of crystallisation, if present, is expelled; soluble bicarbonates, on the other hand, are decomposed, e.g. $2NaHCO_3 = Na_2CO_3 + H_2O + CO_2$.

Insoluble normal carbonates, e.g. calcium carbonate, are prepared by precipitation. The addition of any soluble normal carbonate to a salt of the metal in question brings about the precipitation: $CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$. The precipitate obtained when carbon dioxide is passed into lime-water consists of calcium carbonate: $Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$. When the current of gas is continued, the precipitate redissolves because soluble calcium bicarbonate is formed: $CaCO_3 + H_2O + CO_2 = Ca(HCO_3)_2$.

Calcium and magnesium bicarbonates are known only in solution—they are decomposed by boiling, thus $Ca(HCO_3)_2 = CaCO_3 + H_2O + CO_2$. Many spring waters contain calcium bicarbonate derived from the solvent action of water containing carbon dioxide upon limestone and chalk, which are also forms of normal calcium carbonate. Such waters are termed "hard" because they do not readily form a lather with soap; they are further called "temporary hard" waters because they are softened easily, e.g. by boiling, which precipitates the normal carbonate. Permanent hard waters, on the other hand, are only softened by the addition of a chemical, like washing soda, which precipitates the calcium sulphate contained dissolved in them: $CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$.

The hardness of a water is thus due to the presence of a dissolved metallic salt, usually a salt of calcium, which reacts with the soap and prevents the formation of a lather. As soon as all the dissolved salt has been precipitated by the soap, a lather can be obtained. It is of course very uneconomical to soften water with soap; a measured quantity of washing soda is the best means at hand in the household.

Nearly all insoluble normal carbonates are decomposed by heat into oxide and carbon dioxide. Calcium carbonate is decomposed at above 800°, calcium oxide (quicklime) and carbon dioxide resulting. If the decomposition be effected in a closed vessel the action becomes reversible: $CaCO_3 \rightleftarrows CaO + CO_2$. For every definite temperature and pressure there is a definite quantitative relation between the weights of the interacting substances. The decomposition of a carbonate by heat is a very useful method of preparing an oxide. Carbonates are always identified by the fact that they evolve carbon dioxide with effervescence when treated with a dilute acid.

Experiment LXXII.—*Preparation and properties of carbonates.*

(i) Carbon dioxide is passed into caustic soda solution, say 25 c.c., contained in a small measuring cylinder, until the gas is no longer absorbed. One half of the liquid is evaporated to a low bulk and set aside to crystallise; the other half is treated with 12·5 c.c. of the original caustic soda solution, evaporated and crystallised. (ii) Carbon dioxide is passed into lime-water until the original precipitate has re-dissolved. A portion is boiled, another is treated with lime-water, and a third portion reserved for the next experiment. (iii) A clear solution of Castile soap

in diluted methylated spirits is added drop by drop, with frequent shaking, to (a) tap-water, (b) pure water, (c) the solution reserved from (ii), (d) the same solution after boiling and cooling. The volume of soap solution required to form a permanent lather in each case will give a rough measure of the temporary hardness of the liquids. (iv) Water containing dissolved calcium or magnesium sulphate is treated with sodium carbonate solution until no more precipitate is formed. The relative hardness of the solutions may be tested with soap solution, both before and after precipitation. (v) To prepare a pure specimen of calcium carbonate, calcium chloride solution is precipitated with ammonium carbonate. The liquid is warmed, and when the precipitate has settled the clear liquid is poured off through a filter; distilled water is added, the precipitate is allowed to settle and the clear liquid again poured off. After repeating this operation several times, the precipitated chalk is transferred to the filter and washed repeatedly with hot distilled water until a sample of the filtrate shows no turbidity with silver nitrate solution, showing that all the ammonium chloride and excess of carbonate solution have been washed out. The calcium carbonate is finally dried in an oven and pounded in a mortar. $CaCl_2 + (NH_4)_2CO_3 = CaCO_3 + 2NH_4Cl$.

Estimations of the weight and volume of carbon dioxide obtainable from a metallic carbonate are of considerable importance, and as they can be performed by the student with an accuracy not involving an error of more than 1 per cent., they are described below.

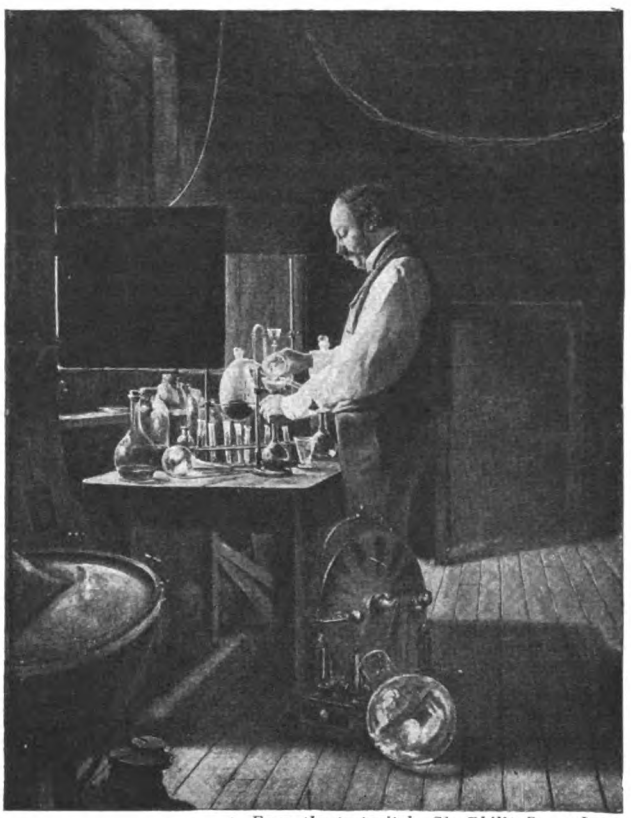
Experiment LXXIII.—*To find the weight of carbon dioxide obtainable from* 1 *gram of marble* (*or other carbonate*).

(i) A small conical flask of about 100-150 c.c. capacity is fitted with a good cork through which passes a drying tube containing calcium chloride and a little cotton-wool. About 25 c.c. of diluted hydrochloric acid (1 : 1) is put in the flask, followed by a little chalk or washing soda. The carbon dioxide evolved serves to saturate the acid and to fill the upper part of the apparatus. The flask and contents are then weighed: also 0·5–1·0 grm. of marble separately. If chalk or other powdered carbonate be used, it must be weighed out in a counterpoised cigarette paper. The carbonate is dropped into the acid, the cork and drying tube are immediately replaced. The carbon dioxide evolved from the carbonate is deprived of its moisture as it traverses the calcium chloride. When the action is over, the flask is re-weighed. By subtracting the last weight from the combined weights of apparatus and marble before the action, the loss in weight due to the escaped gas is obtained. The loss per cent. is then calculated. (ii) If a carbonate be decomposed by heat, the percentage of carbon dioxide in it can be determined by ignition. Forms of calcium carbonate require the high temperature of a muffle furnace, but in some cases the heat from a Bunsen burner is sufficient. Accurate experiments give the percentage as 44.

Experiment LXXIV.—*To find the volume of carbon dioxide evolved when* 1 *gram of marble* (*or other carbonate*) *is treated with acid.*

The apparatus required for this experiment is identical with that used in Experiment XX, and the mode of procedure is essentially the same; but some means must be used to prevent the carbon dioxide from dissolving in the water contained in the large flask. This may be effected by adding, prior to the determination, some concentrated sodium carbonate solution to the water followed by a little concentrated hydrochloric acid and shaking well; the carbon dioxide set free saturates the water so that it does not dissolve this gas during the experiment.

The volume of gas obtained should be reduced to N.T.P. Good experiments will give an average figure of 220–225 c.c.



From the portrait by Sir Philip Burne-Jones.

THE DISCOVERER OF ARGON

A great physicist, the late Lord Rayleigh, at work in his laboratory.

From the results of Experiments LXXI and LXXII the density, or weight of a litre, of carbon dioxide can be readily calculated; and from the density the molecular weight. If 1 gram of marble has been found to yield 0·444 grm. and 225 c.c. at N.T.P. of carbon dioxide, it follows that 225 c.c. weigh 0·444 grm., or 1,000 c.c. weigh $\frac{1{,}000 \times {\cdot}444}{225} = 1{\cdot}942$ grms. Now 1,000 c.c. of hydrogen at N.T.P. weigh 0·089 grm.; therefore the density of carbon dioxide, relative to hydrogen, is $1{\cdot}942 \div {\cdot}089 = 21{\cdot}82$; the molecular weight $= 2 \times 21{\cdot}82 = 43{\cdot}64$. The accurate value is 44.

E. H. T.

ELECTRICITY AND MAGNETISM.—XI

CAREFUL consideration of the relation expressed by Ohm's Law will enable the student to realise that experiments connected with Electro-motive-force and Resistance can be performed by comparing the currents obtained when various electro-motive forces and resistances are used. An ammeter, by which the strength of a current can be read directly in amperes, would be of much use, but as in the case of most pieces of apparatus employed in electrical investigations, ammeters are expensive.

Small pocket instruments can be obtained from an electrician for a sum of about seven shillings each, and a combined voltmeter and ammeter costs about twelve shillings.

Owing to the expensive nature of apparatus, and the fact that one instrument is generally of use for one purpose only, the experiments described in this course are adapted as much as possible to the employment of simple home-made apparatus.

The Astatic galvanometer is merely a current indicator, since it is far too sensitive to measure the strength of currents. We must have some instrument by which currents can be compared with a fair amount of accuracy, and a most important instrument called the *Tangent Galvanometer* will enable us to do this.

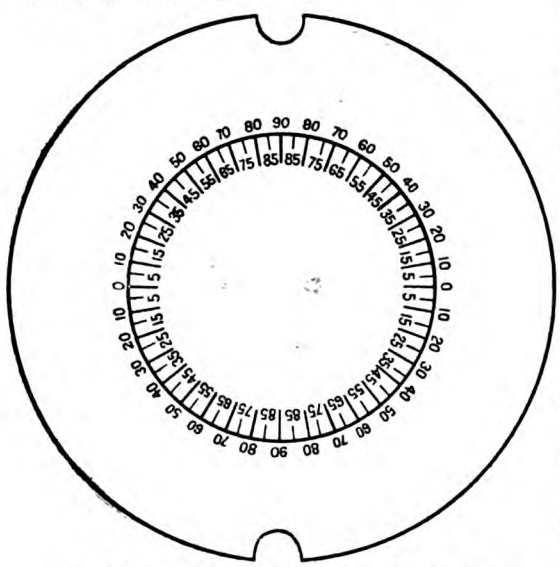


Fig. 38.—How to graduate a galvanometer.

To Construct a Tangent Galvanometer.—Obtain from an ironmonger a piece of very thick copper wire about two feet in length. If copper wire is procurable with difficulty a strip of brass two feet long and about half an inch in width will do nicely. Bend the copper or brass around some circular object, such as a kettle, so that you have a metallic conductor in the shape of an almost completed circle. The ends of the copper or brass should be bent sharply at right angles to the curved portion, and fitted into holes made in a piece of fairly thick wood, which should be about five or six inches square in order to form a firm base for the instrument (Fig. 39).

Care must be exercised to see that (1) the wooden base is flat and of uniform thickness, and (2) the copper or brass is circular and vertical to the horizontal base. We must now find two points A and B, one on either side of the copper circle and such that a level piece of cardboard joining A to B passes approximately through the centre of the circle. In other words A B will be the horizontal diameter, and this being the case it will be the widest horizontal line cutting the circle.

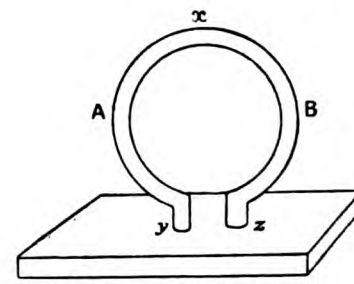


Fig. 39.—Making a simple tangent galvanometer.

By using a piece of thread and a small weight make a short plumb line and attach it to a point *x* at the highest point of the circle. Place your ruler horizontally against the copper and slowly slide it upwards until you find the greatest horizontal width of the circle. The plumb line will assist you in keeping the ruler level as you move it upwards, since the thread of the plumb line and the ruler will form two right angles as long as the ruler is horizontal. Having found the correct positions of A and B, make pencil or chalk marks on the corresponding points of the copper circle. A circular platform extending from A to B and passing just below the centre of the copper circle must now be constructed. Fairly thick white cardboard should be used for this purpose. Measure the distance A B, and add half an inch to the measurement. Suppose the distance to be seven and a-half inches including the extra half-inch. Then the cardboard circle will have a radius of three and three-quarter inches (Fig. 38).

By means of a geometrical compass, draw on the cardboard a circle having the required radius, and cut out the circle. On it rule any diameter. The cardboard will be too wide to fit inside the copper vertical circle from A to B. At each end of the diameter drawn on the cardboard cut out small pieces of the board so that the circle fits tightly and extends horizontally inside the copper from A to B. Be careful not to cut away too much cardboard or the circular platform may be loose, a condition which may cause it to move out of the horizontal plane. On the card another smaller circle having the same centre must be drawn and marked off with degrees, so that the deflection of a magnet which will be placed in the centre of the board may be ascertained. It will be convenient if the smaller graduated circle has a radius of one and a-half inches. The degree marks can be inserted by using a *protractor*, a simple instrument

used for such purposes and obtained from an art dealer's.

The graduation should be performed so that the readings nearest to A and to B are 90°. Halfway round the circle the reading will be 0°. The cardboard can now be fixed permanently in position extending across the square from A to B. All that now remains to be done is to make a small magnet, a pointer, and the means of suspending them.

The magnet must consist of a *small* piece of steel about three-quarters of an inch in length, such as a fragment of a knitting-needle. Magnetise it by the method of single touch. It must be

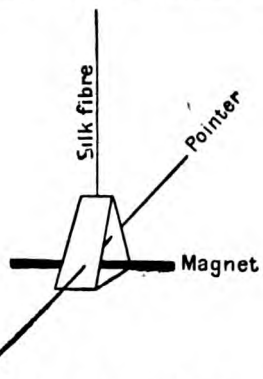


Fig. 40.—How to suspend the magnet.

suspended by means of a single silk fibre and a paper stirrup (Fig. 40), the other end of the fibre being attached to the point x on the copper circle.

When properly fixed the needle will be just above the cardboard graduated circle and in the centre of it. Also it will be in the centre of the copper circle which will conduct the currents of electricity. *The proper centring of the needle is of great importance.* The magnet itself being small, a pointer composed of some light and *non-magnetic* substance is constructed of sufficient length to reach the degree marks on the circle underneath. It should be fixed at right angles to the bar magnet, and this can be effected by pushing it through two small holes pierced in the paper stirrup.

If accurately fixed, the pointer, which should be composed of a straight piece of very thin aluminium or copper wire, will be over the 0° mark when the magnet points directly to 90° on the scale (Fig. 38).

When the needle and its pointer are mounted correctly, the instrument is complete.

The galvanometer so constructed will not be so accurate as one made by professional manufacturers of scientific apparatus, but the student will have constructed at a trifling cost an instrument which will enable him to perform important experiments.

How to Use the Tangent Galvanometer.—In principle the instrument is very similar to that of the Deflection magnetometer by means of which the strength of a bar magnet was balanced against the earth's directive force over a compass needle. In the case of the Tangent galvanometer, the magnetic influence of an electric current is balanced against the earth's directive force. The magnetic needle of the galvanometer, under certain conditions, will be deflected to the right or left, as the case may be, when a current of electricity flows along the copper circle. *The greater the strength of the current the greater the magnetic intensity at the centre of the coil, and consequently the greater the deflection of the magnetised needle, though the angle of deflection is not directly proportional to the current strength.*

If one current flowing along the copper circle causes the needle to be deflected 20°, and a second current produces a deflection of 40°, the strength of the second current is not merely twice that of the first, but is more than twice the strength of the first current.

The relation between current strength and the deflection of a magnet placed in the centre of a circular conductor, such as the copper circle of the galvanometer, is a most important one, which is usually stated:—*The current strength varies as the Tangent of the angle of deflection.* The Tangent of an angle is a certain mathematical ratio which can be definitely expressed in figures, and the student who has no knowledge of trigonometry need not be alarmed, for he can refer to a table of natural tangents of angles, where he will find the numerical value of any tangent.

In the table the tangent of 20° is given as ·364, and that of 40° as ·839. Since the currents are proportional to the tangents of the respective angles of deflection, the strength of the first current

TABLE OF NATURAL TANGENTS OF ANGLES

(Correct to three places of decimals)

Angle in degrees.	Tangent.	Angle in degrees.	Tangent.	Angle in degrees.	Tangent.
1	·017	31	·601	61	1·804
2	·035	32	·625	62	1·881
3	·052	33	·649	63	1·963
4	·070	34	·674	64	2·050
5	·087	35	·700	65	2·144
6	·105	36	·727	66	2·246
7	·123	37	·754	67	2·356
8	·140	38	·781	68	2·475
9	·158	39	·810	69	2·605
10	·176	40	·839	70	2·747
11	·194	41	·870	71	2·904
12	·213	42	·900	72	3·078
13	·231	43	·932	73	3·271
14	·250	44	·966	74	3·487
15	·268	45	1·000	75	3·732
16	·287	46	1·035	76	4·011
17	·306	47	1·072	77	4·331
18	·325	48	1·111	78	4·705
19	·344	49	1·150	79	5·145
20	·364	50	1·192	80	5·671
21	·384	51	1·235	81	6·314
22	·404	52	1·280	82	7·115
23	·424	53	1·327	83	8·144
24	·445	54	1·376	84	9·514
25	·466	55	1·428	85	11·43
26	·488	56	1·482	86	14·301
27	·510	57	1·540	87	19·081
28	·532	58	1·600	88	28·636
29	·554	59	1·664	89	57·29
30	·577	60	1·732	90	∞

is represented by ·364, and that of the second by ·839. Divide ·839 by ·364 and the result is about 2·3. Therefore the second current is about two and a-third times as strong as the first.

Now let us perform actual experiments with the Tangent galvanometer.

Experiment 32.—*To set the galvanometer and take a reading.*

We have seen that the magnetic influence of a wire conducting a current endeavours to pull a compass needle out of the magnetic meridian when both the conducting wire and the compass are in the meridian. Set the galvanometer so that both the magnetic needle and the copper or brass circle are in the line of the magnetic meridian. The magnet will naturally set itself in this direction, and the conducting circle can be brought into line by carefully rotating the base. The process of arranging the instrument in this way is known as *setting the galvanometer*. Fasten short pieces of uninsulated wire firmly at *y* and *z* at the base of the copper circle (Fig. 38). Attach the other end of one of these wires to the zinc terminal of a dry cell. When you are ready to take the reading, note the position of the pointer on the scale of degrees, complete the circuit by firmly pressing the free end of the other piece of wire against the carbon terminal of the dry cell, and note the number of degrees (i.e. the deflection) through which the pointer has moved. Take the reading when the needle is steady.

Whatever number of degrees the magnet moves through the pointer will be deflected, so that the readings are always taken by noticing the pointer. Having noted the angle of deflection, turn up its tangent in the table. Record the results in tabular form thus, supposing the deflection to be 10° :—

Source of Current.	Angle of Deflection.	Tangent.
dry cell	10°	·176

Experiment 33.—*To compare the currents obtained from any two cells A and B.*

Set the galvanometer, attach it to the terminals of cell A, but leave a gap in the circuit in order that the current may not be wasted. Complete the circuit, note the deflection, and again break the circuit. It is as well to check the reading obtained by reversing the direction of the current flowing along the copper circle and take another reading. To reverse the current, all that is required is to change the wires attached to the terminals of the cell and complete the circuit. The average of the two readings may be taken as the angle of deflection. Find the tangent of this angle, and arrange results in tabular form. Do a similar experiment with cell B, and tabulate the results. Compare the two tangent values to obtain a comparison of the currents. Divide the larger tangent by the smaller and you will obtain a result expressing one current as so many times the strength of the other.

It may be excusable if we refer to the deflection magnetometer, one use of which was explained on page 13. As we compare electric currents by obtaining the tangents of angles of deflection, so we can compare the moments of magnets by noting the tangents of the angles of deflection when magnets are placed separately at the same distance from the centre of the magnetometer. This method should be used to check the results obtained by the method involving the cubes of the distances between the magnets and the magnetometer centre.

L. M. P.

BOTANY.—V

12. Soil and Subsoil.—THE relation of the root to the soil is of great importance to the plant, both for mechanical and for chemical reasons; for the soil not only provides an anchorage for the plant and provides water: it also contributes certain necessary constituents of the plant's food. A few experiments on soil will therefore not be out of place at this point.

If the ground be examined in a quarry or fresh railway cutting, it will be observed that three distinct divisions are to be recog-

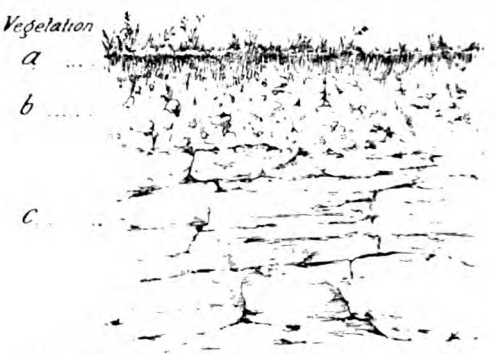


Fig. 27.—*a*, soil; *b*, subsoil; *c*, bedrock.

nised. Proceeding from above, we notice (*a*) a few inches of dark-coloured, friable material, which readily powders—the *soil* proper; (*b*) the soil changes into a rough stony layer, the *subsoil*, not having the dark colour of the soil and, though broken, not so fine in texture; (*c*) the solid, unbroken *bedrock* which is the basis of the whole. The nature of the subsoil shows that it has been formed from the bedrock; it is in fact the upper layer of the bedrock, broken off by the action of water and frost; it is composed of the same materials. Into the composition of the soil, however, a new factor evidently enters; its basis consists of finely attenuated particles of the bedrock; but the presence of decaying leaves, etc., suggests that decaying vegetation in general contributes an important characteristic to its constitution.

The depth of the soil and subsoil varies greatly according to the nature of the bedrock. In some cases, e.g. on a sandy common, it is difficult to distinguish subsoil from the rock below, which at once powders on weathering; the subsoil is loose and deep, and is very permeable to water, while there is a very scanty crop of true soil and an equally stunted vegetation on the top of it. Fig. 27 shows a section exposed in a chalk-pit: here the

soil is very scanty, but the subsoil easily recognisable. A very poor crop grew on the land above. The amount of true soil, in short, depends on various circumstances which we must now study.

13. Classification of Soils.—The two extreme types of soil are the *sand*-type and the *clay*-type. From the agricultural point of view both these extreme types are bad: the latter is too "heavy," because it holds its water too tenaciously; the former is too "light," because it holds too little. Intermediate to these is the *loam*, which is the desirable type of soil. These terms—sand, clay, loam—do not refer to the chemical composition of the soil chiefly, but to its physical condition—to the size of its component particles, which determines its water-holding capacity. When the particles are very small, as in a clay soil, the water is held very tenaciously and cannot move freely; in a sandy soil, where the particles are larger, the water moves freely and easily and the soil rapidly dries.

DEMONSTRATION XVI

A rough idea of the mechanical composition of soil can be obtained by a simple experiment. Take a sample of the soil, and pass it through a fine sieve in order to remove stones and foreign matter. Grind up a portion of the fine soil as finely as possible in a pestle and mortar. Take about a tablespoonful of this, and shake it up with water in a gas jar. After thoroughly shaking, allow the turbid liquor to settle for one minute, and then rapidly pour off the liquid into another jar. Leave this for five minutes, and again pour off the water. Repeat the process after leaving to stand for an hour, and afterwards for twenty-four hours. Allow the deposits to dry, and then examine them. The first deposit will consist of coarse sand, the second of finer sand, the third of clay, the fourth of fine clay, and the water in the fifth jar will remain turbid for many days.

A soil formed on a chalk or limestone bedrock may be of either the clay or sand type, and usually contains comparatively little chalk, owing to the fact that chalk dissolves with fair ease in rain-water, and is consequently removed from the soil. It also dissolves in dilute acids, and from this we can estimate the chalk in the soil.

All soils contain more or less of the dark-coloured matter of vegetable origin, called *humus*. This substance is of complex and variable composition, and is formed by the action of certain bacteria acting in absence of air. Hence, humus forms most in water-logged, clay soils, and least in open sandy soils. Its effect is to render a sandy soil more loamy in texture; in a clay soil its effect is to cause the fine particles to aggregate together into larger groups, and thus to render the soil more workable. When a soil is over-rich in humus, as in woods, it becomes too light and friable; though rich in fertile substances it is not fertile, because it does not hold water. This is often noticed in flower beds which have been well manured for many seasons. A dressing of clay often gives good results in such soils. Humus is of an acid nature, and this is also a disadvantage, as we shall presently see. This may easily be tested in the water that accumulates in boggy ground. Lime or chalk, by neutralising this acidity, is a valuable addition to such stagnant soils.

DEMONSTRATION XVII

Further experiments will now enable us to extend our knowledge of the composition of the soil:

1. Place a little of the finely powdered soil on a weighed watch-glass; weigh again, and thus obtain the weight of soil used. Then let the soil remain for an hour at the temperature of the water-bath—i.e. place it so that it is heated to the temperature of boiling water, but not beyond; let it cool, and weigh. The loss of weight is the weight of water in the sample of soil taken. Repeat the heating, to test whether all the water has been driven off; and calculate the percentage of water in the soil.

2. Weigh another sample of the soil in a weighed crucible. Then heat the crucible to dull redness in the bunsen-flame until the black matter has all been burned away. Weigh again, and calculate the loss of weight which is due to the water and the humus having disappeared.

3. Weigh out another sample of the soil and transfer carefully to a filter-paper in a funnel. Wash the soil thoroughly with distilled water; allow to drain as dry as possible, and then transfer filter-paper and soil to a weighed crucible. Heat to dull redness, until the paper is completely burned up, and the colour of the humus disappears. Weigh the residue, which is the original soil, less the water, humus, and soluble substances. From the result can be calculated easily the percentage of the soil which is soluble in water.

4. Repeat Experiment 3, using dilute hydrochloric acid instead of water. The loss of weight in this case will include the water, the humus, the substances soluble in water, and the substances soluble in dilute acid, of which chalk is the chief.

5. Experiments 3 and 4 do not, however, give perfect results because no allowance is made for the possibility of the humus or some of it dissolving in water. This may be tested by evaporating the water from the liquid which filters through in Exp. 3, at the temperature of the water-bath. Weigh the residue, then heat it and weigh again. The first weighing gives the weight of all the solids dissolved in the water; the second gives the weight of these solids after the humus has been burnt away.

Such experiments as these, though they are not strictly accurate, are nevertheless valuable as giving the student an idea of the relative amounts of the substances

examined. He will gain, as he cannot otherwise, a very useful insight into the nature of the soil.

14. The Soil and Water.—We pass to the consideration of the water in the soil. It is a matter of common observation that some soils dry much more quickly than others after rain. This is of course due to the fact that water percolates some soils more rapidly than others. A clay soil of the extreme type remains muddy for days, until, in fact, the surface dries by evaporation; a sandy soil is dry, on the other hand, in a very short time after the cessation of rain. The general explanation of this is quite simple. The sandy soil is composed of larger particles than the clay, and the spaces between the particles will be larger also, so that the water will flow more quickly through the more open channels than through the fine pores between the clay-particles (Fig. 28). When rain falls on the soil, each particle of the soil becomes surrounded with a film of water, which is held there very tenaciously by the force called *surface-tension* — the force which causes the surface of a liquid to behave as though it were an elastic film, which makes liquid-drops take the spherical form, and which keeps a soap-bubble whole. This film still further reduces the pore-spaces (Fig. 30) between the particles, and causes the flow of water to be still further impeded, till in very fine clays the movement is forbidden entirely. Thus the texture of the soil is a decisive element in fixing its water-contents.

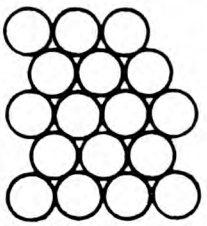


Fig. 28.—Clay soil.

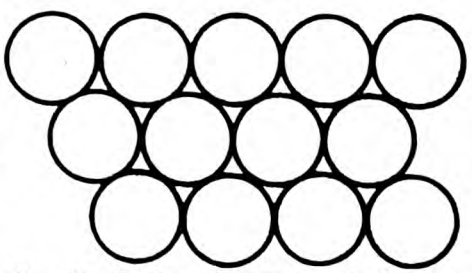


Fig. 29.—Sandy soil is composed of larger particles than clay soil. The space between particles, therefore, is greater.

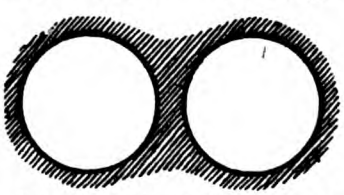


Fig. 30.—Liquid film holding clay particles together.

Again, the regular supply of water to the soil does not come from above but from below. Generally speaking, the water rises in subsoils and soils for the same reason as it rises in a well. As it percolates the upper layers it ultimately comes upon a layer of rock—say granite or clay—which is impermeable. It then soaks to lower levels, accumulates there, and rises into the overlying bedrock and the subsoil above it. It is this subterranean water that acts as a continuous source of water to the soil. It is increased after rainfall, but only a prolonged drought would exhaust it entirely. It does not, however, rise always, or often, into the soil itself. The fine channels among the soil-particles, however, act as capillary tubes (Fig. 29), and the ascent of water into the soil is greatly helped by this capillary action. Reflecting upon these facts, we can understand the effect of watering a soil. Much of the water thus supplied is lost by evaporation; if it can be long continued it restores, temporarily, the surface-films on the soil-particles; but it cannot be the equivalent of a good shower of rain, because it does not affect the underground store, for which, of course, the rain is quite adequate.

Summing up, then—a good soil is one in which the particles are fine enough to hold water reasonably well, but not so fine as to prevent the rise of water from below. The student should perform the following simple experiments:

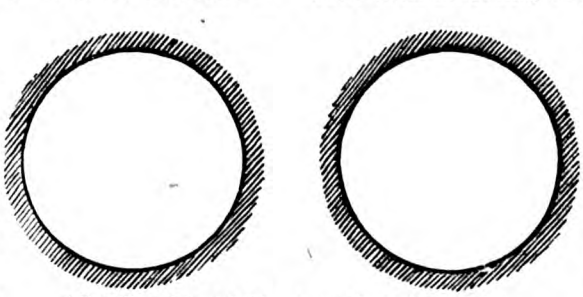


Fig. 31.—Liquid film around sand particles.

DEMONSTRATION XVIII

1. Take three funnels, *a*, *b*, *c* (Fig. 33); place in each a little circle of perforated zinc, and on them put about a tablespoonful of clay (*a*), sand (*b*), and loam (*c*) respectively. On to each now pour enough water to fill the funnel, and collect the water that runs through in test-tubes. It will be seen that none runs through *a*; nearly all through *b*; and a moderate quantity through *c*. Which is the better soil, and why? Mix with some of the clay used on *a* a little lime, and observe that it now behaves more like *c*. The effect of the

lime is to coagulate the clay-particles and thus to widen the pore spaces.

2. Take the turbid water left from the first experiment of § 13; add a little lime to this, and note how the particles settle down and the water becomes clear.

3. Take two glass tubes about 1 in. wide, *d*, *e* (Fig. 32); pack one of them (*d*) with clay, and the other (*e*) with sand. Place them side by side in a vessel of water, and notice how far the water has risen after twenty-four hours.

4. Take three lengths of glass tubing of unequal bore: let two of them be capillary tubes, of different

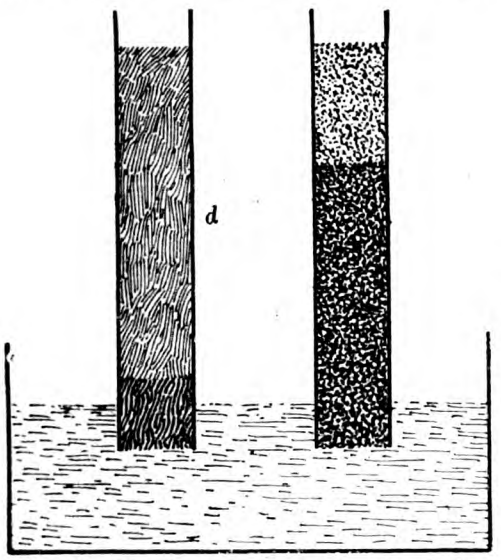


Fig. 32.—Showing how water rises in (*d*) clay and (*e*) sand.

size if possible. Place them in water, and notice the rise of the water in the finer tubes. This rise is due to capillary attraction, and is greatest in the finest tube (Fig. 34).

15. Vegetation on Different Soils.—It is evident that plants which are well adapted to life on light sandy soils are not likely to be equally at home on heavy clay soils, and the student should from the first accustom himself to observe the nature and characteristics of plants growing in the different kinds of soil.

Plants which grow on sandy soils are naturally those which can adapt themselves to a slight water-supply and to a deficiency of humus. Such plants are generally armed in some way against excessive loss of water. As this loss takes place mainly from the leaves, it is in these organs that the chief modifications are to be observed. Thus the leaves may be very small, as in pines, firs, gorse, broom, heather, knapweed, mayweed, yarrow, etc.; or covered with fine hairs, as in silverweed; or have a thick outer layer, or cuticle, as the holly. The whole plant may be small and stunted, as the scarlet pimpernel, corn spurrey, field madder, harebell, and other similar plants of starved soils. Plants which grow in boggy

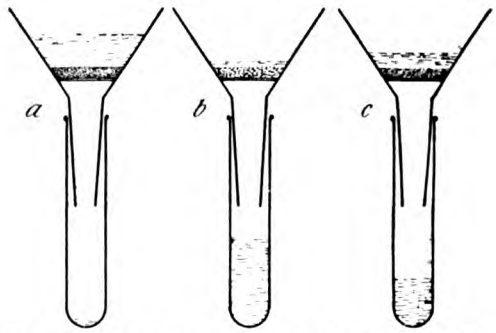


Fig. 33.—To determine which is the best soil: clay, sand, or loam.

land or by the sea, have plenty of water, but cannot absorb it for chemical reasons, and hence resemble those of sandy soils. Other plants refuse lime, and will not thrive except in sandy soils where there is very little lime; these are called *calcifuges*, and among them are such plants as docks, some vetches, lupines, foxglove, etc. When well

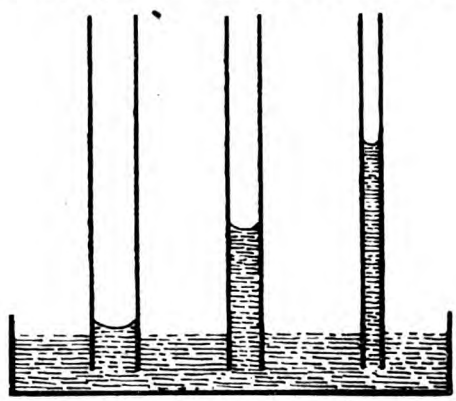


Fig. 34.—Demonstrating the capillary action of the channels between soil particles.

manured, sandy soils suit potatoes, carrots, and other root-crops.

The extreme clay types of soil are unsuited to vegetation, partly owing to their retention of water, and partly to the manner in which they bake on the surface in hot weather. But soils in which clay predominates are very common, and as they are rich in foodstuffs the vegetation on them is usually of a somewhat large and coarse type, as for example the lesser celandine, marsh marigold, and purple orchis.

On loamy soils almost any kind of vegetation will flourish. E. W. E.

SOUND.—I

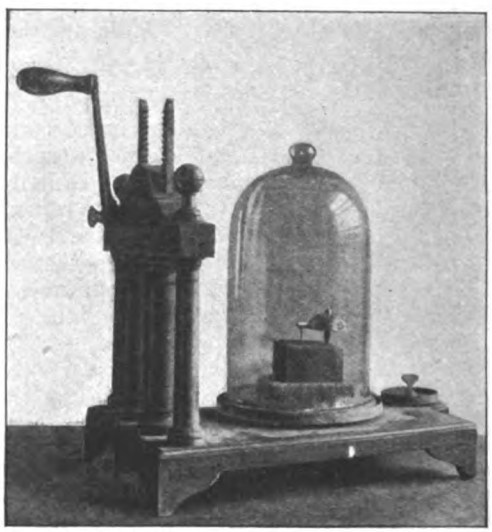
1. General Nature of Sound.—We understand by sound in these lessons that physical agent which is the cause of the sensation of hearing; we have nothing to do with the physiological processes concerned in that sensation, or with the sensation itself.

A sounding body is always in vibration, and it is this vibration that is the cause of sound. It may be the vibration of a metallic rod, as in a tuning-fork; or of a string, as in a harp; or of a column of air, as in an organ-pipe: there is always vibration when there is sound. This is a matter of familiar experience, and easily verified with any sounding body.

The essential feature of vibration is motion to and fro about a central position. It may be simply studied in a simple pendulum.

Experiment I.—

Hang up a heavy bob of lead by a long thread. This is a simple pendulum. Raise the bob a little without loosening the thread. On letting go the bob, it does not return straightway to its position of rest, but continues to move to and fro, i.e. *vibrates* about that position for some time ere coming to rest. What is it that keeps up the vibration? When the bob is displaced, obviously it is the force of gravitation that causes it to return to its lowest position; but when it arrives there, it has a certain amount of kinetic energy, due to its fall, and this energy carries it beyond its central point to almost an equal height on the other side. On coming to rest at its highest point on this side, it is brought down as before, and the same process is continued, until the kinetic energy of the falling bob is ultimately dissipated by the resistance of the air (Fig. 1).



An electric bell fitted up under the receiver of an air-pump will not "ring" when the receiver is exhausted, but the sound can be heard when air is let in again.

Find the time of a single vibration, i.e. of one complete motion to and fro, by counting the number of times the bob passes its central point in a given interval of time. If it passes the centre 24 times in 10 seconds, it makes 12 complete vibrations in that time, which is one in every $\frac{5}{6}$ second. This is known as the *periodic time* or *period* of the vibration. A series of experiments will show that this period is constant for the pendulum, if the width of the vibrations is not too wide.

The vibration of the pendulum is called a *simple harmonic vibration*, and one characteristic of such vibrations is that they are *isochronous*, i.e. all performed at the same rate, if the conditions are unchanged.

In the case of the pendulum, for example, the period would be altered only if the length of the thread were altered.

From this simple study we can obtain some clearer notion what a vibration is. We define a vibration as the complete to-and-fro notion from any point *a* until the body is again at *a* and moving in the same direction. In a vibration we see that the vibrating body comes to rest at the extremities of its swing, and is moving most rapidly at its central point. We learn that the cause of vibration is the operation of a constant restoring force, viz. gravitation, when the bob is displaced. In sound-vibrations this restoring force is provided by the elasticity of the vibrating substance. If a steel rod be clamped at one end, and the free end displaced a little to one side and then loosed, the rod vibrates like the pendulum, as a result of its elasticity. By its elasticity we mean its tendency to recover itself after distortion; if this force of elasticity did not exist, no vibration would occur and sound would be impossible (Fig. 4).

The distance from the central point to the extreme point of the motion is called the *amplitude* of the vibration. Now if the amplitude of a vibration is increased, the moving body has more energy in passing its central point; and this manifests itself in the case of sound-vibrations in an increased loudness of the sound. The intensity of a sound is therefore regulated by the amplitude of the vibrations.

The number of vibrations per second is spoken of as the *frequency* of the vibrations; and in the case of sound this determines the *pitch* of the sound, i.e. whether it is a high or low note. Savart's toothed wheel (Fig. 3) is an arrangement like a circular saw with many small teeth. If it be rotated and a card held lightly against the teeth, each tooth strikes the card in succession, and if the strokes succeed one another with sufficient rapidity a musical note is heard, which becomes higher in pitch as the wheel rotates faster and the frequency of the taps more rapid.

When the pitch of a sound is constant, we get a *musical note*. A *noise* is a sound of uncertain or irregular pitch, and is really probably a mixture of musical notes of different pitch in which one note does not stand out clearly above the others.

2. Waves.—Between the sounding body and the ear, we have next to conceive some mechanism of transmission. All material bodies can transmit sound, and without them sound cannot be conveyed. If an electric bell be fitted up under the receiver of an air-pump, it will not "ring" when the receiver is exhausted, but the sound can be

heard when the air is let in again. Sound travels through air, therefore, but not through a vacuum. It also travels through liquids and solids quite freely. A bell rung under water can be heard by an ear also under the water—indeed, if the bell is far enough away, as in a swimming-bath, it can be heard twice: first by sound transmitted entirely through the water, and secondly by sound which has come partly via the air. And similarly, if the ear be placed close to the ground, sounds can be heard coming through the earth, which are quite inaudible in the air.

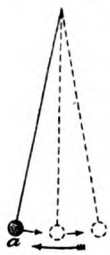


Fig. 1.

An intervening material medium being therefore necessary, we have next to consider how the sound-vibrations are carried through it.

Suppose A B to be a long cord fixed to a hook at B. If the free end A is now held in the hand and the hand sharply vibrated to and fro, the whole cord is thrown into motion in a wavy manner; as a result of the vibration we can observe the wave run along the cord, and return again from B. By suitably timing the vibrations, we can make the cord vibrate as a single loop; increasing the rapidity of the vibrations, we cause the waves to be one-half the length of the cord, or indeed as short as we like. Thus the vibratory motion of the hand is conveyed along the cord as a *wave* which may be reflected at the fixed end and run back to A (Fig. 2).

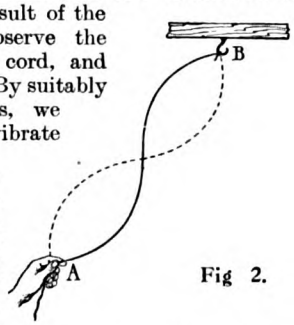


Fig 2.

Similar waves may be induced on the surface of water in a bath if we perform the vibratory motion regularly in and out of the surface; they can be reflected from the edge of the bath, and behave entirely like the waves of the sea.

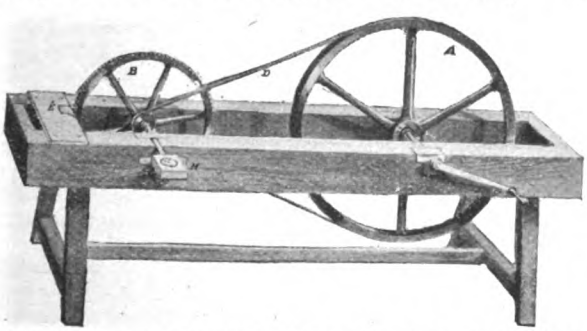


Fig. 3.—Savart's Toothed Wheel. By turning the large wheel, A, a rotary motion is produced by means of the driving band, D, in the toothed wheel, B. A piece of card fixed to the plate, E, touches, and is set in vibration by the teeth.

Now in regard to these waves what we have to realise is:—(1) They are produced as the consequence of vibration. (2) Every particle concerned in the wave vibrates round its position of rest at the same rate, but not necessarily with the same amplitude, as the original vibration. (3) There is no transfer of matter, but only of motion—each particle vibrates only, and is not otherwise displaced. The behaviour of a cork on the surface of the sea impresses this last point upon our minds, and it is very important.

Waves like those on the cord or on the surface of water are called *transverse waves*, because the direction of motion of the vibrating particles is across the direction of the moving wave. Let A B C D E be a complete transverse wave on the plane surface A C E. A little thought will show that every particle on this wave is moving differently, i.e. is at a different point in the vibration. Between A and B, the particles are moving upwards; at B the vibrating particle has come to rest, and between B and C will be moving downwards; at C the particle is at its greatest speed, and between C and D there will be downward motion; between D and E there will be upward motion, and the particle E will be in exactly the same condition as A. Beyond E, the same sequence will be followed in a fresh wave. The points A and E, and any pair of points which occupy corresponding positions on successive waves, are said to be in the same *phase* (Fig. 5 *a*).

Now let us suppose that the period of vibration in A B C D E is one second, and that we draw the position of the moving particles of the wave at intervals of $\frac{1}{4}$ second, $\frac{1}{2}$ second, and $\frac{3}{4}$ second after the position in Fig. 5 *a* was reached. The result will be seen in Fig. 5.

The distance from A to E is the length of the wave (l), and if we know the frequency, n, of the vibrations, the velocity of the waves can easily be calculated. For if n waves, each of length l cms. pass a particular point each second, a length of wave $n \times l$ will have passed by in the second. Hence $v = nl$, where v will be expressed in cms. per second.

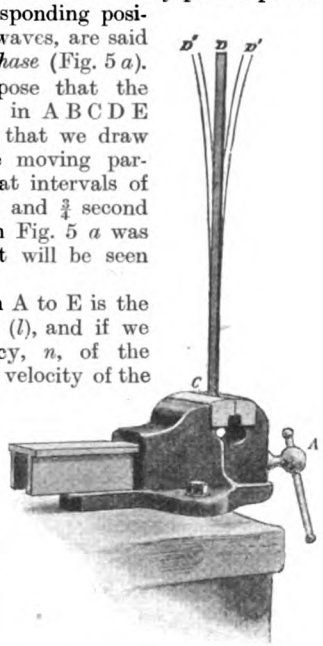
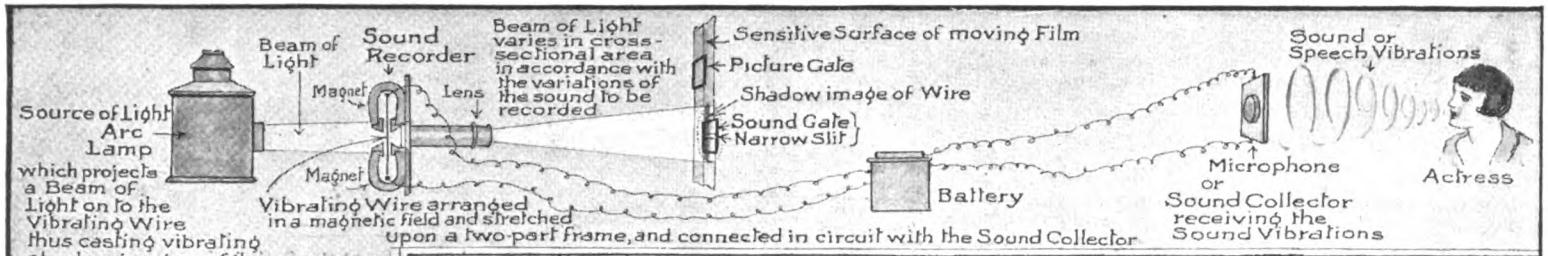


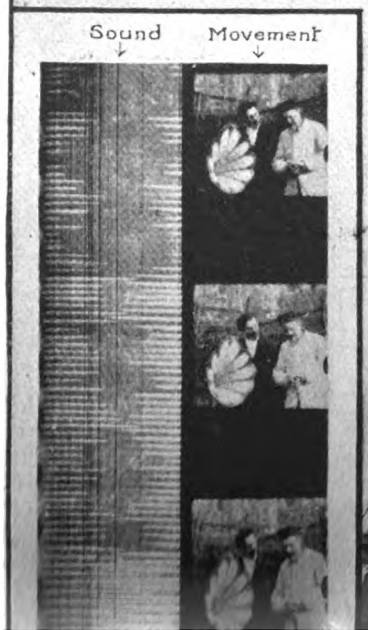
Fig. 4.—C–D is a steel rod clamped at one end. If the free end be displaced, then loosed, the rod will vibrate. D′ to D or D″ to D is the amplitude of the vibration.

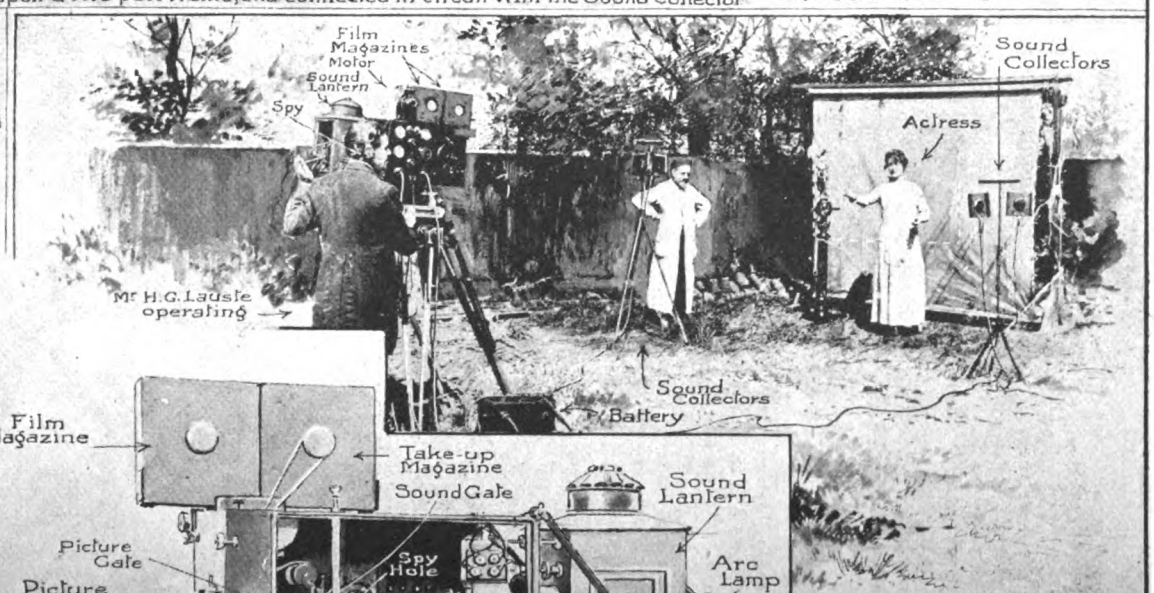
3. Sound-Waves.—The waves by which sound-vibrations are transmitted are not transverse, but *longitudinal*—the vibrating particles in the wave move in the same direction as the wave. Take as an example a tuning-fork. As the prong moves

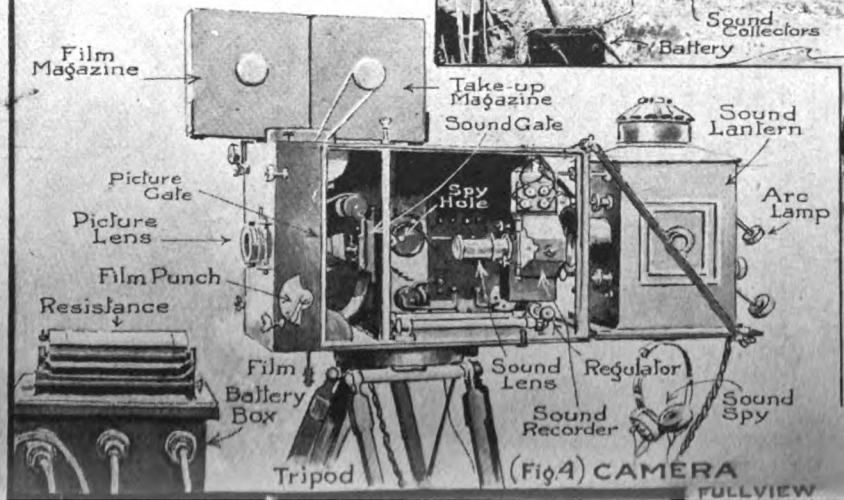


(Fig. 1) SIMPLE DIAGRAM SHOWING ROUGHLY THE PRINCIPLE OF THE PHOTOGRAPHIC RECORDING OF SOUND.

(The impressions of Movements of persons are recorded simultaneously and in exact synchronism with the impressions of the Sound waves)



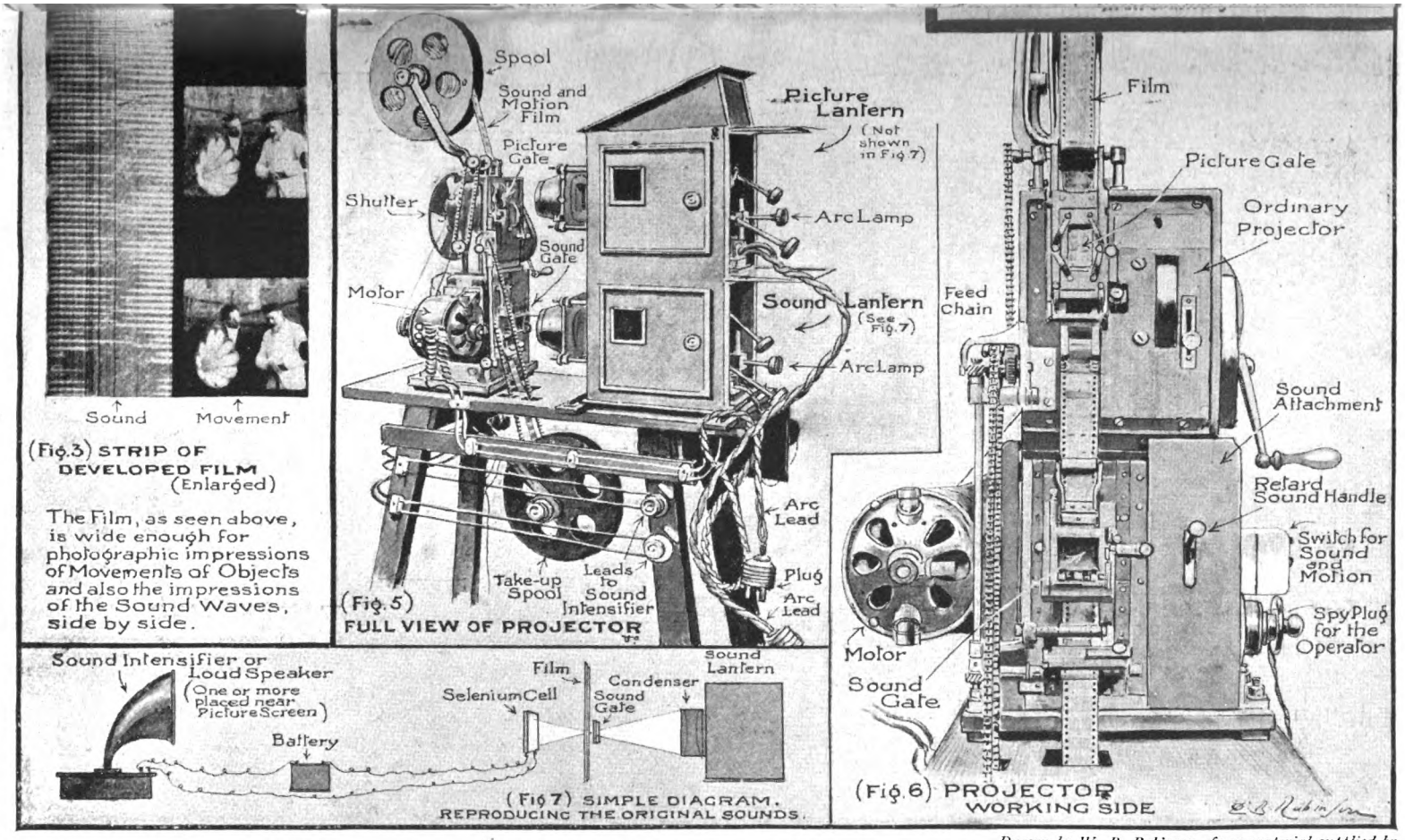




(Fig. 4) CAMERA FULLVIEW

(Fig. 2) SHOWING THE CAMERA AT WORK. Taking both Movement and Sound at one operation.

The Film is operated so that one part is translated continuously past the narrow Slit opposite the side where the Sound Waves are recorded, and the other part is translated intermittently past the Lens as



Drawn by W. B. Robinson, from material supplied by Mr. H. G. Lauste, one of the inventors. By permission of the "Illustrated London News."

TO MAKE "PICTURES" SPEAK

is the next object of those who have already brought movement and colour almost to perfection. Experiments which have been carried out in America give promise of the early synchronisation of sound and movement. Above are indicated the details of the new apparatus. Fig. 1 shows the method of recording sound; Fig. 2, shows the camera at work, a simultaneous record of sound and movement being taken. Fig. 3 shows the results of Figs. 1 and 2—the developed film record. Fig. 4 shows the camera and the relative position of its parts; Figs. 5 and 6 two aspects of the projector; and Fig. 7 the method of using a sound intensifier for the reproduction of sounds recorded by the camera mechanism.

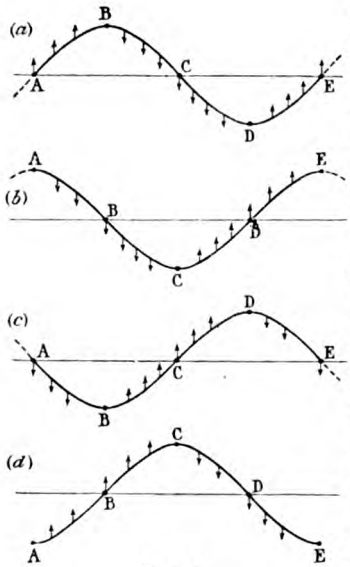


Fig. 5.

forward, it compresses the air in front of it, and that compression is communicated to the air farther out continuously. But the prong, having reached its forward limit, now moves backward; the air through its elastic force recoils with it, and is thus rarefied as much as it was compressed before. Hence the to-and-fro movement of the fork has produced in the air, first, compression, and then rarefaction; and of course this will be repeated at each vibration. Thus the result of the vibration of the fork will be to send out through the air an alternating series of compressions and rarefactions; and it is these that constitute the longitudinal waves which transmit sound. Clearly every particle of air affected by the wave will vibrate at the same rate as the tuning-fork; each will form alternately part of a compression and part of a rarefaction, just as in a transverse wave a particle is now in the crest and now in the hollow of the wave. If we could visualise a particle of air in a sound-wave, we should see it vibrate to and fro in the direction of the sound; a group of neighbouring particles would compress and expand alternately like the spirals in a vibrating spring.

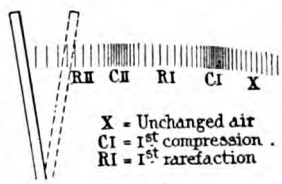


Fig. 6.

Fig. 6 represents the condition of the air in the neighbourhood of a fork after it has made two complete vibrations to and fro; the student should continue the sketch to include a third vibration of the fork.

Experiment II.—*Make a Crova's disc, as follows* (Fig. 7):

On a sheet of cardboard draw a small circle of radius 1 mm., and take eight points at equal distances round its circumference. With one of these points as centre and a radius of 2 mm., draw a circle. Then take the points in order for centre, and draw a series of circles, increasing the radius each time by 3mm. If this series of circles is now spun round its centre, and the movement of the circles examined at any point, it gives a very instructive representation of the motion of the particles in a longitudinal wave.

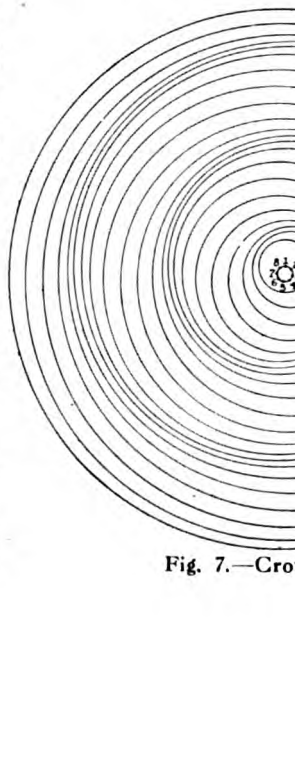


Fig. 7.—Crova's Disc.

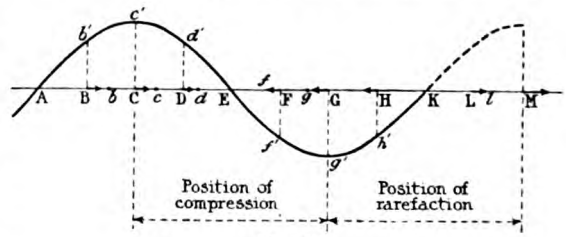


Fig. 8.

To facilitate the observation cover the disc with a sheet of paper from which a rectangular strip has been cut, as indicated by the dotted lines in Fig. 8; the paper must not be rotated with the disc.

Longitudinal waves are obviously difficult to represent clearly in the manner in which we can represent transverse waves. But we can represent them graphically in the following manner (Fig. 8):

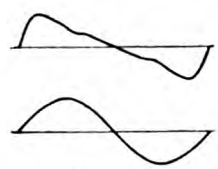


Fig. 9.

Let A, B, C, D, E . . . represent the position of rest of a series of particles subject to a longitudinal wave; and let A, *b*, *c*, *d*, E, *f* . . . represent their positions at a certain instant while the wave is passing. At the points B, C, D . . . erect perpendiculars proportional to the displacement at each point, B*b*′, C*c*′, D*d*′ . . . ; drawing these perpendiculars upwards or downwards according as the motion is forwards or backwards. If we join the summits of these perpendiculars, we obtain a *displacement diagram* of the wave. This diagram represents the transverse wave, which may be said to correspond to the actual longitudinal wave.

E represents the position of maximum compression, and A that of maximum rarefaction.

The shape of the displacement diagram indicates to us the cause of the difference in *quality* of musical notes. Two notes may have the same pitch and intensity, yet differ in musical quality. The displacement diagrams show this to be due to the shape of the wave (Fig. 9).

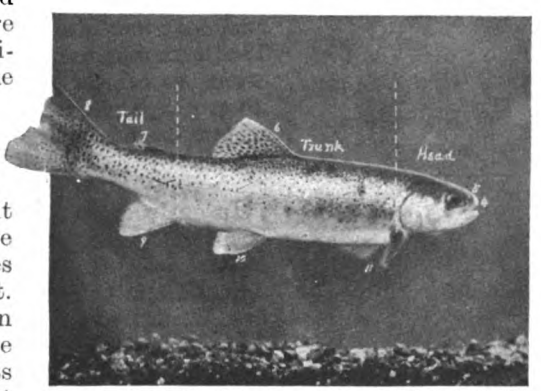
E. W. E.

ZOOLOGY.—XX

If when we think of Life we think of so many distinct species, the result is curiously perplexing. Countless experiments appear to have littered the ages with discarded and broken products. The Giant Stegosaur, the ferocious Dinosaur, the uncouth Naosaurus, there seems to be no limit to the attempts, wonderful and gigantic as many of them were, that led to nothing save the breaking of the mould from which they were cast.

The Fishes

But if we regard all life as being one, deeming its manifold aspects to be no more than so many ramifications of the same plant, we think less of the forms that Life has assumed than of the ceaseless struggle it has waged to survive the ceaseless changes in its environment. Its audacity has been boundless, its resource unlimited. From its bed in the ocean it flung its tentacles ashore, and from the moment that it did so, it multiplied its shapes with inconceivable prolixity; well satisfied if from amongst a hundred different shoots even one survived.



By permission of Dr. Francis Ward, F.Z.S., F.R.P.S.

RAINBOW TROUT.

The external features of the fish are: 1. Lateral line; 2. Gill opening; 3. Gill cover; 4. Snout; 5. Nostril; 6. First dorsal fin; 7. Second dorsal fin; 8. Caudal fin; 9. Anal fin; 10. Pelvic fins; 11. Pectoral fins.

So for countless ages Life struggled upon the land for the right to continue to be, modifying its shapes again and again until the guises in which it now exists above high water mark appear superficially to bear little relationship to those in which it fills the oceans from pole to pole. The contrast is, indeed, the greater since concurrently with its efforts to overrun the land Life has been engaged in a continuous struggle for complete possession of the seas. Neither upon the land nor in the seas has the contest ever ceased.

Conditions within the ocean, however, have been more constant and, the demand being lighter, Life's answering efforts have been less drastic. It is true that the armour-clad monsters of prehistoric days have disappeared and that many new races have arisen and have been superseded. But so far as we know, Life has not produced within the waters to anything like the same extent those bizarre and extraordinary types which at one time or another have embodied its demand for existence upon the land.

Of the various classes which to-day people the deep, undoubtedly the most interesting to man is the one known as *Pisces* or the Fishes. Like any mammal the fish needs oxygen, but unlike all mammals, birds, insects and other animals the fish has the power to extract it from water. The oxygen required by the fish is the same oxygen which man absorbs with the air, the fish merely obtains it through an additional medium, through the water, that is, in which the air is dissolved. This power, however, implies an ability of another order, since it is obvious that if a fish required the same amount of oxygen, proportionate to its size, as a man it would soon be asphyxiated. The fish, therefore, is able to thrive upon extremely minute doses of this element.

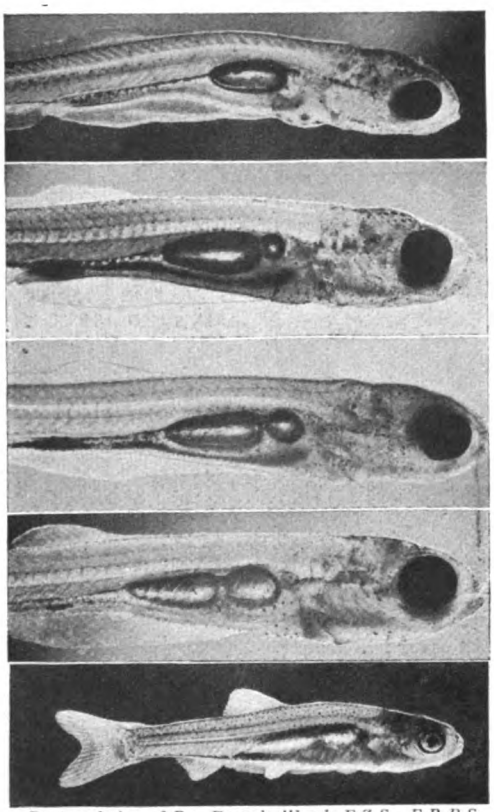
Taking the weight of a man as ten stone and that of a tench at two pounds, a man weighs only seventy times as much as a tench, and should not require pound for pound more than seventy times as much oxygen to sustain life. But Dr. Gunther, whose name is a household word amongst those who make a study of fish life, estimates that a man actually consumes fifty thousand times as much oxygen as a tench.

Floating Capacity

No less important, therefore, than the ability of the fish to extract oxygen from water is the fact that it actually requires very little oxygen at all.

A peculiar possession of some fishes—it is not shared by the entire class—is of considerable interest since it explains how it is that a fish with a specific gravity greater than that of water, is able to float above the floor of the ocean. An aeroplane possessing a specific gravity much greater than that of air when it ceases to move swiftly forward

falls to the ground, and the same remark is true of some fishes. But others, as has been said, appear when floating to be uninfluenced by any consideration of weight. The explanation of this apparent contradiction is to be found in an air bladder containing not air as is commonly supposed, though a gas consisting of nitrogen and oxygen. By means of this the buoyancy of the body is increased or diminished.



By permission of Dr. Francis Ward, F.Z.S., F.R.P.S.

AIR BLADDER OF A ROACH.

Showing the growth of the bladder, which runs along the body just under the backbone, and is common to most of the bony fishes, by means of which the buoyancy of the body is increased or diminished.

But the air-bladder still leaves unanswered such a riddle as is presented by a fish that swims in an upright position though its back is heavier than the lower part of its body. Were the skilled draughtsmen of the Cunard Line called upon to design a steamship of which the deck and superstructure was to be heavier than the hull, they would instantly point out that the suggestion was absurd since such a vessel would turn over the moment it was launched. But many fish designed upon lines quite as preposterous, swim in every fair-sized stream in Britain. How is it that they do not turn over? To answer this and many similar questions, we must examine those useful appendages, the fish's fins.

These fins, which in most cases number five, are termed pectoral, ventral, dorsal, anal and caudal. Of these the two first mentioned are set in pairs and approximate as nearly as may be to the fore and hinder limbs of the land animal. But while the position of the pectoral fins immediately behind the head is common to all species, that of the ventral fins varies considerably. It is by the use of these fins that the fish preserves its balance, regulates its speed, and to a certain extent steers its course. The three remaining fins, taken in the same order as originally mentioned, are placed upon the back, far back beneath the body and upon the tail.

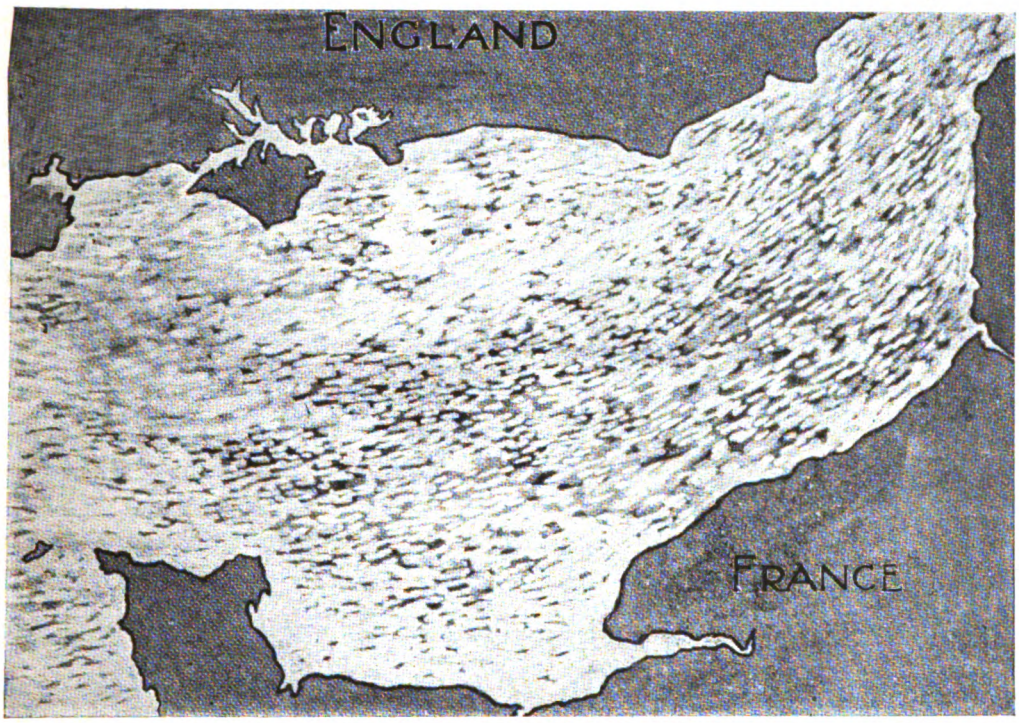
Uses of the Fins

In early days these fins are said to have been continuous in all fish as they still are in the eel. One of the chief uses of the dorsal fin is to preserve the balance of the fish, though it is also of service in assisting it to steer its course. The anal fin like the dorsal is chiefly important as an aid to direction. Deprived of the anal and dorsal fins, the fish experiences the greatest difficulty in steering a steady course. The caudal fin has uses with which all are familiar; it forms the extremity of the tail, which is, of course, in true fishes the main organ of propulsion.

Though different species of fishes may vary considerably as regards their form, there are sharply defined limits to such variations as they show, so that in the main they can be said to be so many developments of the one ideal form for propulsion through water. Greater differences are perceptible in the manner in which the species are clad. For scales, though common, are not universal, and even among such species as carry them are far from uniform in design. While some fish like the lamprey are entirely destitute of scales, others like the eel carry them in so rudimentary a form that they can scarcely be detected from the flesh. Again, while the scales in their most perfect form overlap one another, as is the case in the perch, there are several species in which the scales, though existing, are widely separated, as, for instance, in some carp.

The skin of the fish, however formed, is,

in the vast majority of cases, very sensitive, so that the lightest touch upon occasion can sound the *sauve qui peut.* It does not follow from this, however, that the nervous system of the cold-blooded fish, the lowest of the vertebrates, is abnormally developed. Probably the reverse is true. And this is known to be sensitive, it is probable that the mere physical pain suffered by a fish when hooked is very slight. The horror which a man feels on receiving a shocking wound is not caused by the present pain, but by apprehension of the consequences . . . but a fish can have no dread of ulterior evil."



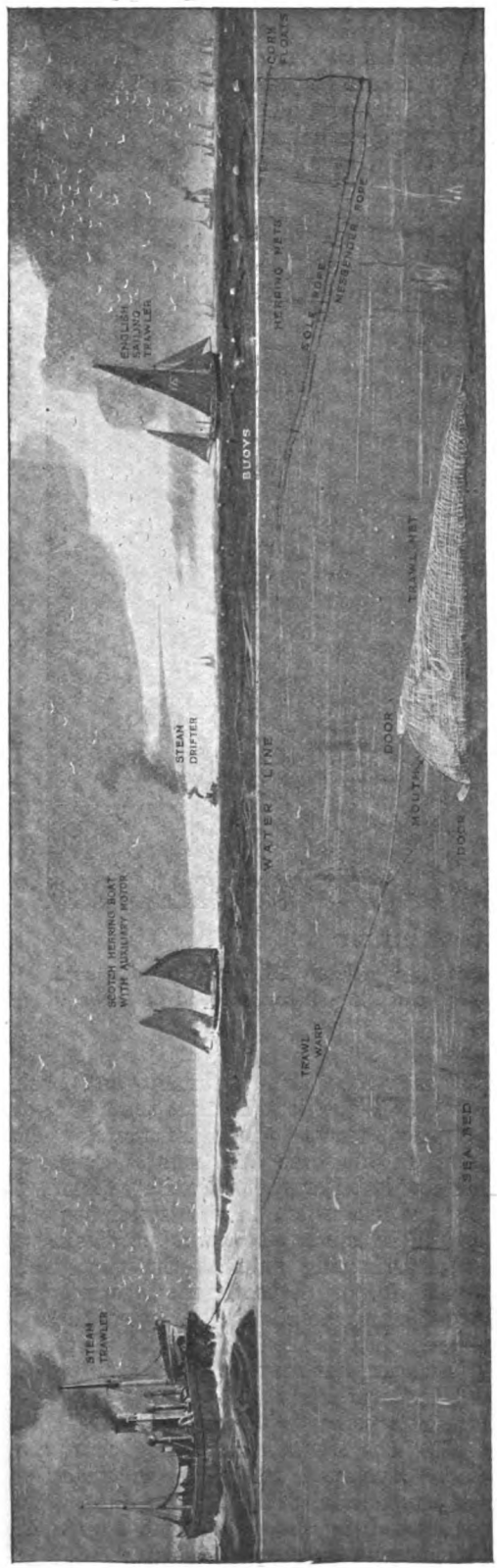
IF THEY ALL CAME TO MATURITY

and bred once, the fish from the roe of one parent cod would completely fill the English Channel. As a matter of fact only a small number hatch, for cod's spawn is a favourite food of a host of sea creatures.

not perhaps so idle a question as some might imagine, for more than one good angler would forgo his rod and line if he really believed his catch to experience all the tortures its antics suggest.

Sir Herbert Maxwell, F.R.S., in "British Fresh Water Fishes" makes a most interesting suggestion on this point. "Whether it be the overwhelming sense of terror," he writes, "or some other anæsthetic influence which renders the victim of a mortal crisis insensible to bodily pain, I know not, nor am I bold enough to speculate; but I have the testimony of two men—one of whom has been mauled by a tiger, the other by a lion—that during the mauling they felt no pain. . . . . Paradoxical as it may seem, therefore, in view of the degree in which the bodies and organs of fish are

But may not this argument cut both ways? Is it not possible that the fish feels his physical torture the more acutely just because in his case the mental torment which could obliterate it is entirely lacking? Surely the fish which cannot anticipate the future is in much the same predicament when experiencing pain as the man who need not do so. A toothache is unaccompanied by any dread of ulterior evils, but we do not feel it the less on that account. But however that may be, the lower we go in the scale of life the less acute physical suffering appears to be, and it is more probable that the fish struggling upon the hook is concerned to evade an unaccustomed restriction of its liberty than that it is tortured by the pain which a man in similar circumstances would feel.



PICTORIAL DIAGRAM ILLUSTRATING THE USE OF TRAWL AND DRIFT NETS.

When we consider the dangers to which the eggs of fish are exposed, and which further constantly menace the young of almost all the species, it appears at first almost miraculous that the oceans are not rapidly denuded of life. A solitary steam drifter fishing for herrings will often take in a single night one hundred "crans" of 870 fish each. If for one drifter we estimate for hundreds and for one night, many nights, we can gather some idea of the prodigious inroads, amongst the adult of some species, for which man alone is responsible.

But so fearful have been the perils that the herring has been called upon to surmount before ever he found his way into the net of the drifter that, even in the face of this disaster, he could with justice lay claim to having accomplished a feat against the performance which odds of several thousands to one would not have been extravagant. But Nature, always careless of the individual and thoughtful for the race, has provided against the danger of extermination by making the fish the most prolific of breeders.

Prolific Breeders

It is no longer held that the herring inhabits the open ocean, only approaching the northern coasts of Europe at different seasons. Its haunts are mainly in the North Sea, and the northern parts of the Atlantic Ocean.

During the spawning seasons the herring comes closer in to the shore, preferring shallow water. Its growth is very rapid. It lives on crustaceans and marine animals. As an article of food the herring is of first importance.

A solitary herring will lay 25,000 eggs, a halibut 3,500,000, a sturgeon 7,000,000, a ling, it is said, 150,000,000; whilst so fertile is the cod that the fish—if they all came to maturity and bred once—from the roe of one parent cod would fill the English Channel. As a matter of fact, however, only a small number of cod's eggs ever hatch, for the spawn of the cod is a favourite food of a host of sea creatures. Even father cods are not averse to a feast of egg clusters.

"Regrettable incidents" may be of continual occurrence in the life history of a species, but they cannot suffice to extinguish it. Beneath the placid surface of the sea the work of slaughter goes merrily forward. At every moment thousands succumb, at every moment thousands hurry to fill the vacant places.

A. B.

ANATOMY AND PHYSIOLOGY.

I

THE necessity for a wide diffusion of knowledge of the elements of human anatomy and physiology, if the laws of health are to be properly understood, is so self-evident that any attempt to assign reasons for it may at first sight appear to be an exercise in the obvious. Even now, however, although physiology finds some slight recognition in the curricula of a few of our secondary schools as a basis for the teaching of hygiene, there is still in many quarters but an imperfect recognition of the bearings of anatomical and physiological science upon everyday life. It is well, therefore, that an attempt should be made to suggest by some simple yet not insignificant instances the practical implications of the course of lessons to which these paragraphs are introductory.

Ductless Glands

First, however, it may be remarked that while considerable tracts of physiology are still shrouded in obscurity, light has of late years been shed upon much that was formerly mysterious. This may be illustrated by a reference to what are known as the ductless glands—glands which, though not furnished with channels that carry away their products, none the less form secretions that are taken up either by the blood-stream or the lymph-stream.

Not so long ago we were almost entirely ignorant of the functions of these glands; now, although there is still much to be learned about them, we know that they produce chemical substances of immense potency, and that their relations with each other and with other organs of the body are of the most intimate character, so that if one ceases to function, or functions to excess or irregularly, the whole economy may be gravely prejudiced. In this as in all other respects the lessons that follow, although not professing to be more than elementary, will be found to present their subject according to the newest lights.

One of the first impressions which the thoughtful student of the lessons cannot fail to receive is that of the marvellous complexity of the human body, with its multitude of tissues and forces and functions. When Solon exhorted man to know himself, his conception of the difficulty of the enterprise was probably far inferior to that with which immensely greater knowledge has endowed us.

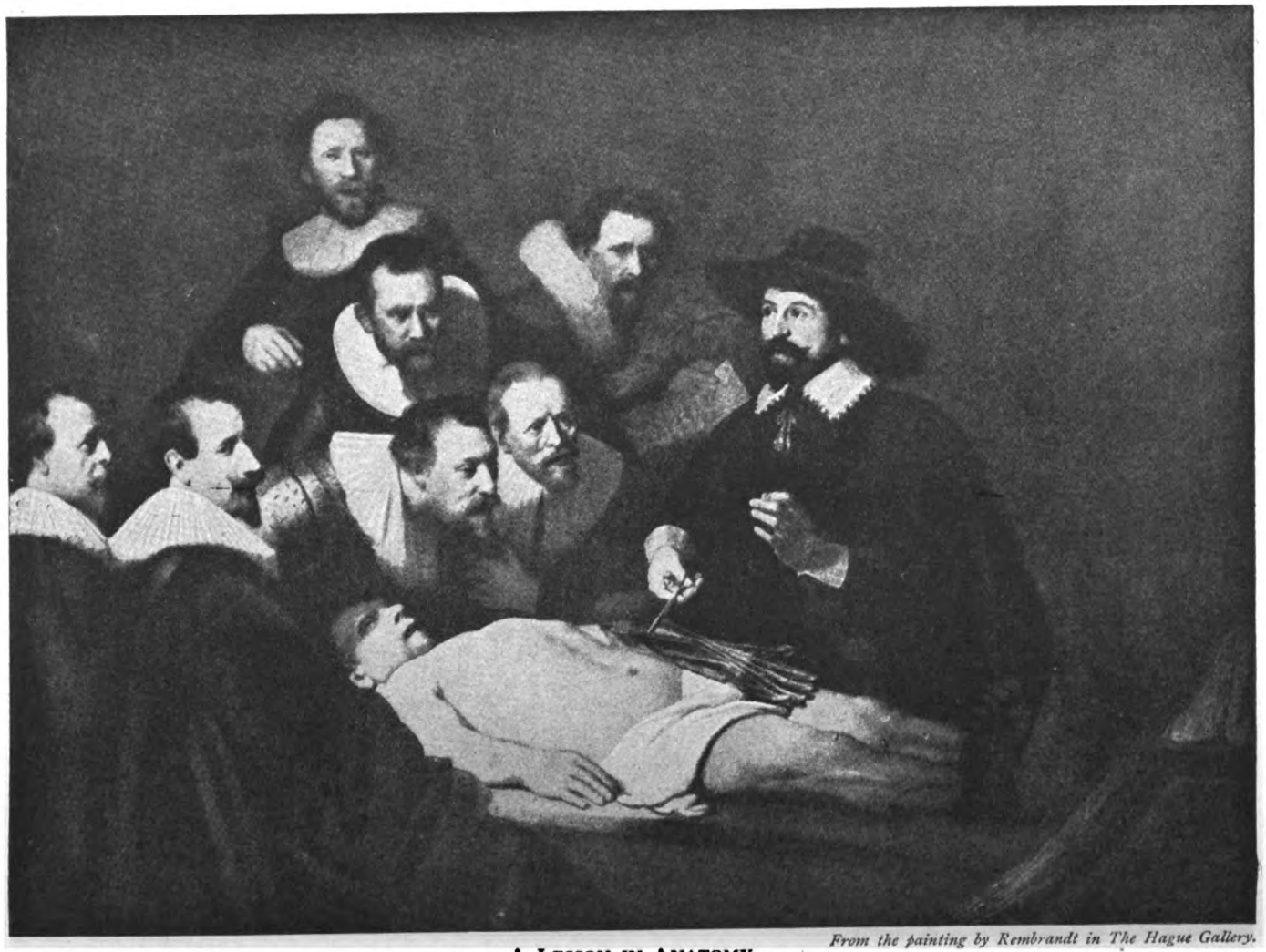
Even if, altogether leaving out of account those mental faculties which to Shakespeare made man seem "how like a god," we confine ourselves to his physical nature, what an indescribably intricate subject do we find we have in hand when we endeavour to understand him! What wonders of adjustment are brought to light by a study of the human body, and how amazingly delicate, in varying degrees, are the structures of which it is composed! And the inference which the attentive student cannot but draw is that to throw these beautiful adjustments out of gear, or to subject these delicate structures to avoidable injury, whether by neglect or by misuse, is to convict ourselves of folly so gross as to be almost criminal.

To many persons the skin connotes no more than the body's outer covering, consisting of two structures, the scarf skin and the true skin, and beset with pores which enable it to take part in the excretion of waste material. But the student of these lessons will learn that those two structures are composed of a number of different layers, that the layers are made up of a great variety of tissues, and that the true skin is furnished with a multitude of blood-vessels, lymph-vessels, glands, ducts, fat-cells, and nerves. He will learn, too, that in addition to its work of excretion the skin helps to regulate the temperature of the body; that by virtue of its nerves of touch and sensation it is one of the most important of the sense organs; and that it and its glands are the habitat of a whole flora of micro-organisms, some of them ever ready to spring into baleful activity.

Preservation of Teeth

Having had this explained to him, he will inevitably have brought home to him the necessity for sedulously cleansing and caring for and preserving from injury an integument so charged with important functions, and so obviously exposed to danger—danger from cold and heat, from light, from friction with clothing, and from a great variety of irritating substances, as well as from the grosser lesions which we call wounds.

The teeth, again, which may be regarded as an appendage of the skin, deserve all the care that can be bestowed upon them, and certainly a great deal more than they usually receive from those who lack knowledge of the anatomy of these structures or of the perils which beset them. That they are seldom preserved in their entirety after



From the painting by Rembrandt in The Hague Gallery.

A LESSON IN ANATOMY.

The lesson is being given by Professor Tulp, a seventeenth century Dutch anatomist.

middle age, but have so soon to be supplemented by the mechanical skill of the dentist, is due to the fact that so few understand until too late the necessity for taking the most scrupulous care of them, so as to preserve them from the ravages of the bacteria which are always lying in wait to attack them.

Were they from the beginning regularly cleansed night as well as morning, and periodically examined by the dentist, so that as soon as any speck of "decay" presented itself it might be removed, there is no reason why in many cases they should not be carried into old age in good working order.

The work which the teeth perform is the first of the many elaborate processes, physical and chemical, by which food is so transmuted as to be capable of absorption and assimilation. The most elementary acquaintance with the laws of physiology should suffice for the avoidance of many errors by which the organs of digestion are thrown into disorder.

Reading at Meals

One mistake, and a serious mistake, not uncommonly made by studious persons, is that of engaging in mental occupation while eating, or soon after eating. Physiology shows that unless attention be paid to this act, so that there is a due appreciation of flavours, the salivary glands will fail to pour out in sufficient abundance the juices which convert starch into sugar, and thus work which ought to be done in the mouth and soon after the food has entered the stomach is postponed until, in the small intestine, the chyme is subjected to the action of the pancreatic secretion. Nor will there be a proper secretion of the gastric juice, for it is now known that in the secretion of the gastric as of the salivary juice there is a psychical as well as a physical factor.

To most of us it is an aid to digestion to eat in pleasant company and savour our food with light and discursive talk; but even this diversion from the business of the moment is not good for all, for some are like Charles Lamb, who complained that his friends would never leave him to eat alone, "a process," he says, "absolutely necessary to my wretched digestion." Physiology teaches, also, that while the stomach is in the early stage of churning the food and bringing to bear upon it the ferments contained in its secretions it requires an ample supply of blood, which it will not receive if the brain is at the same time kept hard at work. There is the still more common error of encumbering the stomach with more food, and especially nitrogenous food, than it is able to digest. A very little physiology will make it clear that nutrition depends not upon the amount of food that is eaten, but upon the amount that is digested and assimilated.

From the alimentary we may pass to the circulatory system.

The student who has once clearly grasped the conception of the heart as the mighty organ upon whose efficient working during every moment of existence our physical well-being depends, and of the arteries as the tubes, wonderful in their mingled delicacy and strength, which carry the blood to the minutest recesses of the body, is less likely than he was in the days of his ignorance to impair the rhythmical action of the one by excessive indulgence, say in tobacco, or to damage the other by overstrain in athletics, or by exposing them to the action of poisons such as alcohol, not to speak of the still more deadly toxins of those avoidable diseases which are the penalty of departures from moral rectitude.

We may next consider the finest and most elaborately constructed of the sense organs.

Who that has acquired any appreciation of the delicacy of the many structures which enter into the formation of the eye can fail to be sensible of the importance of taking the utmost care of an organ which can so easily be injured and the loss of which is irreparable?

"Total Eclipse"

It can be harmed by alcoholic intemperance; by immoderate smoking the condition known as "tobacco blindness" can be induced; by undue strain "the light of the body," as the Scripture poetically terms the eye, may be dimmed if not turned into darkness.

Foolish indeed is it to risk straining or damaging this most precious organ by immoderate or unreasonable use, save in some great cause such as that for which Milton was content to spend the last twenty-two years of his life in "total eclipse." And when in the course of nature the eye begins to need artificial help, the instructed person will not think of putting himself at the mercy of an optician—whose proper business it is to make glasses, not prescribe them—but will avail himself of the practised skill of an oculist.

It is not possible to refer to every part of the human organism in which a knowledge of the laws of our physical nature is of practical service, but a brief allusion must be made to the most complicated of all the various systems into which the body is divided.

By reason of the fineness of its tissues, the intricacy of its functions, and the intimate relations which subsist between it and every other organ, the nervous system is, perhaps, more liable to derangement than any other,

From the portrait by James Northcote, R.A. Photo: Emery Walker.

EDWARD JENNER, M.D., F.R.S. (1749–1823), **who discovered the effects of vaccination which was announced as a preventive of small-pox in 1796.**

and the consequences of a derangement of this system are correspondingly graver and more far-reaching.

Use of Narcotics

In no other system is it so easy to set up what in pathology is termed a "vicious circle," by the use of narcotics or stimulants, by weak indulgence—for it is an indulgence—in worry, or by any kind of excess, be it even so innocent in itself as excess of mental work, for the evil effects produced in these various ways upon nervous tissue at once react upon the other parts of the economy, and these retaliate by aggravating the disorder in the nervous system.

An intelligent appreciation of the laws of man's physical nature, such as may be gained from these lessons, falls easily into line with that great development of modern Medicine which has issued in the creation, in this and in other countries, of the vast system of Public Health. The ramifications of this system are almost endless.

It begins to concern itself with the citizen before he is born, and its interest in him only ceases when under its regulations he has been either buried or cremated.

Public Health

It does something, though not enough, to ensure the purity of the milk upon which the child is largely nourished. It follows him into the school and searches out any defects in his health, in order that they may be corrected before they have become firmly established.

For example, the school clinic does splendid service to the young of both sexes

From the portrait by J. S. Stamp, by permission of the Royal College of Surgeons, Edinburgh.

ROBERT LISTON (1794–1847).

Probably the most dexterous, quick, and brilliant surgeon the world has known. Liston operated before the introduction of anæsthetics.

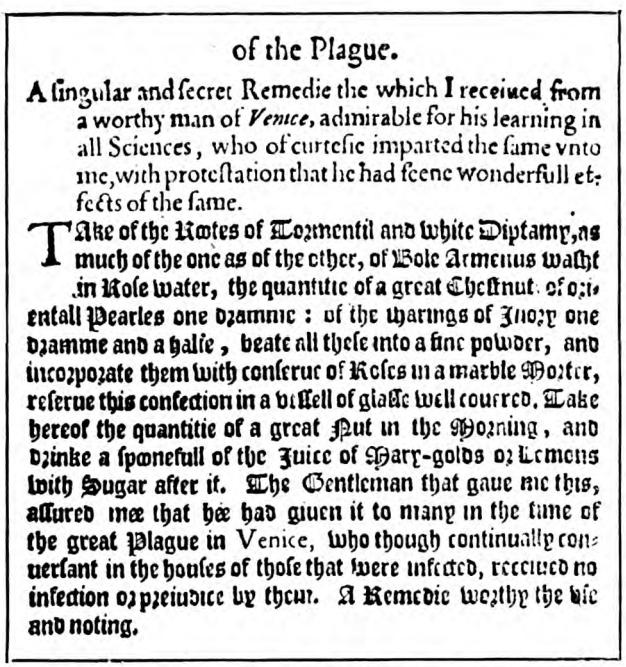
in eradicating evils which arise from decayed teeth, and in correcting defects of eyesight that were a cause of dullness and headaches amongst children of a generation ago.

Then again it insists upon adequate air space in the building in which he more or less impatiently cons his lessons; it sees that the house in which he dwells is free from sanitary defects; it inspects, with the same intent, the "works" in which he may presently have to earn his daily bread. If

he is engaged in an unhealthy trade, it takes protective steps to reduce the dangers to a minimum.

If he falls sick, it furnishes him, partly out of contributions which it has wisely exacted from him while in health, with medical attendance and medicine, and makes him a weekly allowance so that his home may not be broken up. If he is tuberculous, it sends him in the earliest stage of the disease to a sanatorium.

Furthermore, if he is attacked by one of the infectious fevers, it insists, in the interests of the community, upon a notification of the fact to the public authority, provides for his isolation and treatment, and, if he is treated at home, undertakes the disinfection of the house. If he loses his reason, it opens to him the doors of an asylum. And in a hundred other ways it strives to shield him from influences obnoxious to his health and to minimise the evil effects should he succumb to them.



of the Plague.

A ſingular and ſecret Remedie the which I receiued from a worthy man of *Venice*, admirable for his learning in all Sciences, who of curteſie imparted the ſame vnto me, with proteſtation that he had ſeene wonderfull effects of the ſame.

TAke of the Rootes of Tormentil and white Diptamy, as much of the one as of the other, of Bole Armenus waſht in Roſe water, the quantitie of a great Cheſtnut. of Orientall Pearles one Dramme: of the Harings of Ivory one Dramme and a halfe, beate all theſe into a fine powder, and incorporate them with conſerue of Roſes in a marble Morter, reſerue this confection in a Viall of glaſſe well couered. Take hereof the quantitie of a great Nut in the Morning, and drinke a ſpoonefull of the Iuice of Mary-golds or Lemons with Sugar after it. The Gentleman that gaue me this, aſſured mee that hee had giuen it to many in the time of the great Plague in Venice, who though continually conuerſant in the houſes of thoſe that were infected, receiued no infection or preiudice by them. A Remedie worthy the vſe and noting.

A PRESCRIPTION AGAINST THE PLAGUE.

Reproduced from a *Treatise of the Plague* by T. Lodge, 1603. The Plague of 1603 cost London a sixth part of its population.

Now, the ultimate object of all that the State, either by its own officials or through the local authorities, does in these directions is not so much the cure as the prevention of disease, and therefore it is that the Public Health system is known alternatively as Preventive Medicine. To cure disease, when it has arisen, is important; but to prevent it from arising is vastly more important.

To illustrate the success with which this great aim is being prosecuted it is necessary to cite only two or three out of the multitude of facts which might be put in evidence. Small-pox, which formerly claimed its hosts of victims, is now rarely heard of; cholera and plague occasionally knock at our door, but find it barred and bolted; typhus fever, a filth disease, which in the year 1865 killed 108 people in every hundred thousand in Scotland, is now so rarely met with in that, or in any other, part of Great Britain that when it occurs it is occasionally mistaken for something else; and many other infectious diseases have in different degrees been brought under control. And these results, though due in part to better methods of treating disease, have to a far greater extent been produced by sanitation, which is but a synonym for the prevention of disease; and "prevention is better than cure."

These pregnant facts are sufficient to indicate the great things which Preventive Medicine has done. But if it is to fulfil all its possibilities it must have the intelligent co-operation of the people. Proof abounds on every hand that education is still needed in the preventive medicine which is concerned with the health of the community, and similarly education is needed also, as is suggested in what has been said about physiology, in the preventive medicine which has to do with the health of the individual.

Good health in the individual postulates good health in the aggregate life; and it follows that a sound mind in a sound body must define the working unit of national prosperity.

And those who have arrived at a due sense of the importance of caring intelligently for their own health will find it an easy transition to care not less intelligently for the health of the community. The two things, indeed, in the last analysis, are but one.

No man can be said to live to himself alone, and by an instructed care for his personal health he necessarily promotes the health of the nation. M. M.

Continued from page 353.

LANGUAGES:

***Contributors*:**—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A.[Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—XXIII

THE rules of agreement are summed up, as we have seen, in three concords. These we will now consider in detail.

The First Concord

A finite verb agrees with its subject in number and in person. The subject is a substantive (noun or pronoun expressed or unexpressed) in the nominative case, e.g.:—

Nauta navigat,
The sailor sails.

Nautae navigant,
The sailors sail.

Vos nautae navigatis, Nos nautae navigamus,
You sailors sail, we sailors sail.

Hostis hostem occidere volui,
As an enemy I wished to kill an enemy.

Nouns which, being singular in form, have a plural signification, are called collective nouns or nouns of multitude. A collective noun may obviously be regarded in two aspects, either in relation to the individual objects or in relation to the whole which these unitedly compose. In the former case collective nouns have a plural meaning, and consequently take a plural construction; in the latter, they present a single idea and take a verb in the singular. In the one case the noun is used distributively, and in the other collectively.

But the same subject may have a plural and a singular verb in the same sentence, as

Pars major receperunt sese, pars perstitit ad vallum,
The greater part fled, a part stood firm at the rampart.

In this sentence Livy, by the judicious use of a plural and a singular verb, depicts first the scattered fugitives and then the close-knit phalanx of the band that kept its post. A similar shade of difference in the sense is effected by Virgil in the sentence:

Pars stupet innuptae donum exitiale Minervae, et molem mirantur equi,
A part stands astonished at the fatal gift of the virgin-goddess Minerva, and (they) marvel at the enormous size of the horse.

In **Athenae fuerunt urbs**, *Athens was a city*, the grammatical form rather than the sense is observed, the name **Athenae**, *Athens*, though plural in form, being singular in meaning.

In the sentence

Amantium irae amoris integratio est,
Lovers' quarrels are the restoration of love,

the copulative verb **est** agrees with the predicate, not the subject—a case of attraction, the verb agreeing with the nearest word.

The Second Concord

Again, an adjective, participle, or adjectival pronoun, used either as an attribute or a predicate, agrees with its substantive in gender, number, and case. Examples:

Patria Ciceroni carissima est,
His country was most dear to Cicero.

Carthago est delenda,
Carthage must be destroyed.

The construction known as apposition may be treated here. Apposition is the relation of a substantive to another substantive to which it serves as an attribute, as in

Tomyris, regina Scytharum, Cyrum, regem Persarum, devicit,
Tomyris, queen of the Scythians, conquered Cyrus, king of the Persians.

Quæ ego consul dixi vera sunt,
The things are true which I said when I was consul.

When substantives are thus in apposition they agree with each other in case but not necessarily in number. Thus we find that nouns in apposition may differ from each other in both gender and number, as in—

Tomyris, deliciae Scytharum,
Tomyris, the delight of the Scythians.
Tomyris, patriae decus,
Tomyris, the glory of her country.

The same principle applies to nouns used as predicates, since we may evidently construct sentences in which these substantives are connected by the verb *to be* instead of being in simple apposition, thus—

Tomyris fuit deliciae Scytharum,
Tomyris was the delight of the Scythians.

In such a sentence as the following :—

Varium et mutabile semper est femina,
Woman is alway a variable and changeful thing,

the adjectives **varium** and **mutabile** may be regarded as qualifying an unexpressed noun put in the neuter gender because it stands simply for a thing of a certain class, though it is predicated of the feminine noun **femina**, *woman*. This construction, very frequent in Greek, appears again in

Turpe senex miles, turpe senilis amor,
An old man a soldier is an unseemly thing, unseemly is an old man's love.

In the last sentence, notice that **senex** and **miles** are in apposition.

The Third Concord

A relative pronoun agrees with its antecedent in gender, number, and person, and also in case if they are in the same clause. The antecedent is the substantive to which the relative pronoun in a dependent clause refers back; thus, in the sentence already cited—

Coloniam quam Fregellas appellant,
The colony that they call Fregellae,

Coloniam is the antecedent to **quae**. Since they are in the same clause (only part of the sentence being quoted here), they agree not only in gender, number, and person, but also in case. On the other hand, in the following :—

Libri quos ad te misi optimi sunt,
The books that I have sent are very good,

the antecedent **libri** is the subject of the principal sentence, **libri optimi sunt**, *the books are very good*, and the relative **quos** is in the dependent, defining clause, **quos ad te misi**, *which I have sent to you*; **quos**, therefore, need not agree with **libri** in case, though it must agree in gender, number, and person.

An apparent exception to the rule appears in the following :—

Pompeio, quod populi Romani lumen fuit, extincto,
Pompey, who was the light of the Roman people, being dead.

There **quod**, which in sense is the relative to the antecedent **Pompeio**, is in a different gender, having been attracted to the neuter substantive, **lumen**, of the dependent clause.

A different kind of attraction appears in the following :—

Cecidere manu, quas legerat herbas,
The herbs which she had gathered fell from her hands,

where **herbae**, the subject of **cecidere**, is attracted into the case of the relative and becomes the accusative **herbas**.

Quam quisque novit artem in hac se exerceat,
Let each exercise himself in that art with which he is acquainted.

The antecedent is sometimes repeated with the relative—a construction making for extreme clearness and much affected by Cæsar—thus :—

Erant omnino itinera duo, quibus itineribus domo exire possent,
There were in all two roads, by which roads they were able to depart from their home.

Sometimes a demonstrative is implied in the relative, as in **Quae tua est prudentia**, equivalent to **Ea prudentia quae tua est**, or **Qua tu es prudentia**, equivalent to **Ea tu es prudentia qua**, etc., where **qua**, in the ablative, has the sense of **ut**, indicating a result, and is followed by the subjunctive, as in—

Qua es prudentia nihil te fugiet,
You are of such forethought that nothing may escape your notice.

In all these more complex illustrations the rule, however, is clearly observed that the relative agrees with its antecedent in gender, number, and person, and also in case when they are in the same clause.

Compound Agreement

Compound agreement, the agreement of one word with several other words, arises in the case of a composite subject. Strictly according to rule such a subject should take a plural verb, thus—

Pompeius, Lentulus, Scipio, Afranius fœde perierunt,
Pompey, Lentulus, Scipio, and Afranius perished miserably.

In the same way they should take a plural adjective, thus—

Pater et filius mortui sunt,
The father and son have died.

But in the examples given above there is no conflict of gender or person. When substantives forming the composite subject are of different genders or persons various alternatives present themselves. The main alternative is whether the adjective and verb shall be in the plural or be attracted by the nearest substantive and be put in the singular. In the following both are attracted by the first substantive **Messalina**, thus—

Convicta est Messalina et Silius,
Messalina and Silius were convicted.

This may be regarded as an abbreviation of the correct but cumbrous sentence :—

Convicta est Messalina et Silius convictus est,
Messalina was convicted and Silius was convicted.

Or the verb may be put in the singular number because the composite subject conveys one single idea, as in—

Tempus necessitasque postulat,
Time and necessity demands.

The alternative is that the verb should be put in the plural, when the following rules govern the treatment of gender and person :—

(*a*) Substantives of different gender denoting persons have this adjective in the masculine, as—

Pater mihi et mater mortui sunt,
My father and mother are dead.

(*b*) Substantives or different genders denoting things have their adjective in the neuter, as in—

Secundae res, honores, imperia, victoriae, fortuita sunt,
Prosperity, honours, commands, victories, are gifts of fortune.

Sometimes the adjective is put in the neuter even if the nouns denoting things are of the same gender, as in—

Fama et existimatio valde cupienda sunt,
Reputation and good name are (things) greatly to be desired.

If the subject consists of substantives of different persons, the verb agrees with the first person rather than the second or third, and with the second person rather than the third. Thus—

Ego et Pompeius profecti sumus,
I and Pompey set out.
Tu et ille profecti estis,
You and he set out.
Si tu et Tullia valetis, ego et Cicero valemus,
If thou and Tullia (you) are well, I and Cicero (we) are well.

This is in accordance with English idiom, by which *you and I* constitute *we*, and *thou and he* constitute *ye*.

Instead of the plural, the singular sometimes occurs, as—

Ipse meique ante Larem proprium vescor,
I myself and my friends eat at our own hearth.

Exercise 22

Translate into English :—

1. Est quaedam flere voluptas. 2. Vera incessu fatuit dea. 3. Debemur morti nos nostraque. 4. Cuilibet in arte sua credendum est. 5. Aurea ne credas quaecunque nitescere cernis. 6. Errare malo cum Platone quam cum istis vera sentire.

Translate into Latin :—

1. The ambassador, being questioned, answered nothing with regard to these matters. 2. The Roman wishes to see Athens, the Athenian Rome. 3. It is virtue to shun vice. 4. Blind riot of plunder and rapine was carrying you away. 5. Which can be perceived neither with the eyes nor the ears nor by any sense. 6. I mean (say) that city upon which you have brought war.

E. A. B.

FRENCH.—XXIII

The irregular Verbs of the -oir Conjugation fall into two classes, differentiated by the ending of the past definite. In the first the past definite ends in **-us,** as in **déchus,** past definite of **déchoir,** *to fall*, the past participle ending in **-u,** as in **déchu.** The second class consists of only two verbs, **asseoir,** *to sit*, and **voir,** *to see*, both having the past definite in **-is,** thus **assis, vis**—but unlike in the ending of their past participles, viz., **assis** and **vu.**

Class I

DÉCHOIR, *to decline, to fall*
Déchoir, déchu, je déchois, je déchus.

IND. PRES.	IMPERF.
je déchois	je déchoyais
nous déchoyons	nous déchoyions
ils déchoient	etc.
etc.	
PAST DEF.	**FUT.**
je déchus	je décherrai
nous dechûmes	nous décherrons
etc.	etc.
COND. PRES.	**IMPER.**
je décherrais	déchois
nous décherrions	déchoyons
etc.	déchoyez
SUBJ. PRES.	**SUBJ. IMPERF.**
que je déchoie	que je déchusse
que nous déchoyions	que nous déchussions
qu'ils déchoient	etc.
etc.	

Échoir, *to fall due*, is similarly conjugated in the few parts in use, viz., present participle **échéant,** past participle **échu,** third person pres. ind. **échoit,** past def. **j'échus,** etc., fut. **j'écherrai,** etc., cond. pres. **j'écherrais,** etc., subj. imperf. **que j'échusse,** etc.

FALLOIR, *to be necessary, must*
Falloir, fallu, il faut, il fallut.

IND. PRES.	IMPERF.
il faut	il fallait
PAST DEF.	**FUT.**
il fallut	il faudra
COND. PRES.	
il faudrait	
SUBJ. PRES.	**SUBJ. IMPERF.**
qu'il faille	qu'il fallût

MOUVOIR *to move*
Mouvoir, mouvant, mû, je meus, je mus.

IND. PRES.	IMPERF.
je meus	je mouvais
il meut	nous mouvions
nous mouvons	etc.
ils meuvent	
etc.	

PAST DEF.
je mus
nous mûmes
etc.

FUT.
je mouvrai
nous mouvrons
etc.

COND. PRES.
je mouvrais
nous mouvrions
etc.

IMPER.
meus
mouvons
mouvez

SUBJ. PRES
que je meuve
que nous mouvions
qu'ils meuvent
etc.

SUBJ. IMPERF
que je musse
que nous mussions
etc.

PLEUVOIR, *to rain*

Pleuvoir, pleuvant, plu, il pleut, il plut.

IND. PRES.
il pleut

IMPERF.
il pleuvait

PAST DEF.
il plut

FUT.
il pleuvra

COND. PRES.
il pleuvrait

SUBJ. PRES.
qu'il pleuve

SUBJ. IMPERF.
qu'il plût

POUVOIR, *to be able, can*

Pouvoir, pouvant, pu, je peux (or **puis**), **je pus.**

IND. PRES.
je peux or puis
tu peux
il peut
nous pouvons
vous pouvez
ils peuvent

IMPERF.
je pouvais
nous pouvions
etc.

PAST DEF.
je pus
nous pûmes
etc.

FUT.
je pourrai
nous pourrons
etc.

COND. PRES.
je pourrais
nous pourrions
etc.

SUBJ. PRES.
que je puisse
que nous puissions
etc.

SUBJ. IMPERF.
que je pusse
que nous pussions
etc.

SAVOIR, *to know*

Savoir, sachant, su, je sais, je sus.

IND. PRES.
je sais
il sait
nous savons
etc.

IMPERF.
je savais
nous savions
etc.

PAST DEF.
je sus
nous sûmes
etc.

FUT.
je saurai
nous saurons
etc.

COND. PRES.
je saurais
nous saurions
etc.

IMPER.
sache
sachons
sachez

SUBJ. PRES.
que je sache
que nous sachions
qu'ils sachent
etc.

SUBJ. IMPERF.
que je susse
que nous sussions
etc.

VALOIR, *to be worth*

Valoir, valant, valu, je vaux, je valus.

IND. PRES.
je vaux
tu vaux
il vaut
nous valons
vous valez
ils valent

IMPERF.
je valais
nous valions
etc.

PAST DEF.
je valus
nous valûmes
etc.

FUT.
je vaudrai
nous vaudrons
etc.

COND. PRES.
je vaudrais
nous vaudrions
etc.

IMPER.
vaux
valons
valez

SUBJ. PRES.
que je vaille
que nous valions
qu'ils vaillent
etc.

SUBJ. IMPERF.
que je valusse
que nous valussions
etc.

VOULOIR, *to be willing, to wish*

Vouloir, voulant, voulu, je veux, je voulus.

IND. PRES.
je veux
tu veux
il veut
nous voulons
vous voulez
ils veulent

IMPERF.
je voulais
nous voulions
etc.

PAST DEF.
je voulus
nous voulûmes
etc.

FUT.
je voudrai
nous voudrons
etc.

COND. PRES.
je voudrais
nous voudrions
etc.

IMPER.
veuille (veux)
veuillons (voulons)
veuillez (voulez)

SUBJ. PRES.
que je veuille
que nous voulions
qu'ils veuillent
etc.

SUBJ. IMPERF.
que je voulusse
que nous voulussions
etc.

Class II

ASSEOIR, *to seat, to set, to place*

Asseoir, asseyant, assis, j'assieds, j'assis.

IND. PRES.
j'assieds
il assied
nous asseyons
ils asseyent
etc

IMPERF.
j'asseyais
nous asseyions
etc.

PAST DEF.	FUT.
j'assis	j'assiérai (asseyerai)
nous assîmes	nous assiérons
etc.	(asseyerons), etc.
COND. PRES.	**IMPER.**
j'assiérais (asseyerais)	assieds
nous assiérions	asseyons
(asseyerions), etc.	asseyez
SUBJ. PRES.	**SUBJ. IMPERF.**
que j'asseye	que j'assisse
que nous asseyions	que nous assissions
qu'ils asseyent	etc.

VOIR, *to see*

Voir, voyant, vu, je vois, je vis.

IND. PRES.	IMPERF.
je vois	je voyais
il voit	nous voyions
nous voyons	etc.
ils voient	
etc.	
PAST DEF.	**FUT.**
je vis	je verrai
nous vîmes	nous verrons
etc.	etc.
COND. PRES.	**IMPER.**
je verrais	vois
nous verrions	voyons
etc.	voyez
SUBJ. PRES.	**IMPERF.**
que je voie	que je visse
que nous voyions	que nous vissions
qu'ils voient	etc.
etc.	

VOCABULARY

amicalement, *kindly.*
amoureux, *amorous.*
avant-hier, *the day before yesterday.*
attendre, *to wait for.*
le cabaret, *the tavern.*
se cacher, *to hide oneself.*
combien de fois, *how many times.*
combien de temps, *how long.*
décider, *to decide, determine.*
dénicher, *to unearth, discover.*
d'où, *whence.*
l'écheveau, *the skein.*
le fil, *the thread.*
le front, *the forehead.*
haut, *high.*
malade, *ill.*
manquer, *to be short of* or *without.*
se marier, *to get married.*
le menton, *the chin.*
où, *where.*
la parole, *one's word.*
par où, *by which way.*
plaindre, *to pity.*
le raisonnement, *reasoning, thought.*
relever, *to raise, lift.*
résolûment, *resolutely.*
le ressort, *the spring.*
rester, *to stay.*
ridicule, *ridiculous.*
le voyageur, *the traveller.*

Exercise 43

1. Je sors de la maison bien décidé à n'y rentrer. 2. Il faut que je te raconte mon expédition de point en point. 3. Cela vaut bien les honneurs de la narration. 4. Dût celle que je cherche se cacher au fond du royaume de Cathay ou de Samarcande, je la saurai bien dénicher. 5. Je n'ai jamais pu tenir parole à personne, pas même à moi même. 6. Si je dis : j'irai là demain, il est sûr que je resterai. 7. Si je me propose d'aller au cabaret, je vais à l'église. 8. Si je veux aller à l'église, les chemins s'embrouillent sous mes pieds comme des écheveaux de fil. 9. Je suis sorti résolûment, de la maison le front haut, le menton relevé, le regard hautain. 10. Je m'en allais donc par les rues. 11. Il n'y a que les beaux et les riches qui puissent être amoureux sans être ridicules ou à plaindre. 12. Ils sont malades, ils ne peuvent pas marcher. 13. Tu vois qu'il ne manque rien. 14. Mais jamais de ma vie je ne pourrai faire une chose comme celle-ci. 15. Je le comprends par raisonnement, mais je ne le sens pas. 16. Voilà le ressort qui meut la machine. 17. Elles s'assirent sur l'escalier. 18. Vous verrez mieux d'ici. 19. Je suis mal tombé. 20. Sachez que ma fille se marie.

Exercise 44

1. Which way did those travellers come ? 2. How long did you live in Italy ? 3. How many times have you been there ? 4. How late did you wait ? 5. Where do you come from, my friend ? 6. Which way has your friend gone ? 7. How long is he going to stay there ? 8. He is going to stay there till the spring. 9. Where do those English ladies come from ? 10. Which way did they come ? 11. Did you not receive your relative in a friendly way when he came ? 12. I received him as well as I could. 13. Did our school-children grow weary of waiting so long yesterday ? 14. They had to wait so long that in the end they lost patience. 15. Did you not read your brother's letter the day before yesterday ? 16. Why did you not write more quickly this morning ? 17. Because I was afraid of making a mistake. 18. I do not know where my father is. 19. Do you know where George is ? 20. Do you know who has just knocked at the door ?

Key to Exercise 40

1. Que faut-il faire aujourd'hui ? 2. Il a fallu travailler toute la journée. 3. Ne lui faut-il pas aussi de l'argent ? 4. Il lui en faut beaucoup pour payer ses dettes. 5. Je puis l'y envoyer tous les dimanches, s'il le veut. 6. Je veux vous l'envoyer, si vous en avez besoin. 7. Nous ne voulons voir qu'eux. 8. Ma mère courut à moi, et me dit qu'elle avait toujours pensé à moi. 9. Nous accourûmes à sa voix. 10. Les forces lui défaillent. 11. L'avez-vous ouï dire ? 12. Avez-vous bien dormi ? 13. Le prêtre lui a donné du pain bénit. 14. Je pars pour l'Italie cette après-midi. 15. Elle viendra si vous le voulez. 16. Il ne me convient pas de lui écrire. 17. Votre fusil vaut-il autant que le mien ? 18. Voulez-vous aller chez mon père ? 19. Je ne le lui ai pas demandé. 20. Que me faut-il faire ?

Key to Exercise 41

1. Your relation writes pretty well and pretty fast. 2. Do not your boots fit you well ? 3. They do not fit me properly, they pinch me too much. 4. Has the priest gone away ? 5. When did your sister's companions leave ? 6. Is the coat that you hold yours or your brother's ? It fits him very well, and becomes him well. 7. We went away too late. 8. I have tried it on, but it does not fit me. 9. Whose books have you brought ? 10. I have brought my brother's books. 11. They belong neither to me nor to you. 12. At what are you delighted ? 13. Why do you make haste ? 14. He likes playing, he never studies. 15. Do you like being at your relations' house ? 16. We do not like being there. 17. Is that man angry with the clerk ? 18. Is he often very angry ? 19. Make haste, it is noon already. 20. Are you not wrong to go so early ?

E. A. B.

GERMAN.—XX

Verbs Compounded with Prefixes (*Continued*).—Ab has a negative meaning in raten, *to counsel*, abraten, *to dissuade*; weiſen, *to direct*, abweiſen, *to reject, turn away*; flechten, *to twist* or *braid*, abflechten, *to untwist, unbraid.*

An.—The chief meanings of this are "on," "on to," "to," at," and "up."

In the sense of "on," "on to," "to," or "at" we have the following: ſtecken, *to stick* or *pin*, anſtecken, *to stick* or *pin on*; ſetzen, *to set* or *place*, anſetzen, *to place on, to join* or *affix*; kommen, *to come*, ankommen, *to come to, arrive*; beten, *to pray*, anbeten, *to pray to, adore*; bellen, *to bark*, anbellen, *to bark at.*

The idea of "up" is chiefly represented in compounds which mean to "begin to do" a thing. Thus: ſtimmen, *to tune*, anſtimmen, *to strike up*; beißen, *to bite*, anbeißen, *to begin to eat*, or *to bite the first piece out of a thing*; bahnen, *to make a path*, anbahnen, *to begin to make a path.*

Auf.—This has two main meanings, (*a*) "upon," "on to," (*b*) "up." Thus: (*a*) ſetzen, *to put, place*, aufſetzen, *to place upon, to put on* (one's hat); bürden, *to load*, aufbürden, *to load on to.* (*b*) hängen, *to hang*, aufhängen, *to hang up*; fordern, *to summon, demand*, auffordern, *to call up, invite*; ſitzen, *to sit*, aufſitzen, *to sit up.*

It denotes "opening." Thus: machen, *to make*, aufmachen, *to open*; reißen, *to tear*, aufreißen, *to tear open*; and hence with the idea of reversal, ſchließen, *to lock*, aufſchließen, *to unlock.*

It denotes "completeness," very often in conjunction with the idea of reversal, in the following: eſſen, *to eat*, aufeſſen, *to eat up*; geben, *to give*, aufgeben, *to give up, renounce*; heben, *to lift*, aufheben, *to lift up*, but also *to break up, reverse*, or *abolish*; decken, *to cover*, aufdecken, *to uncover.*

It denotes "repetition" in such compounds as: kochen, *to cook* or *boil*, aufkochen, *to boil up* or *reboil.*

It intensifies the action of the verb in cases in which the simple verb denotes to "store." Thus: bewahren, *to keep*, aufbewahren, *to keep safely* (by putting away); ſpeichern, *to garner*, aufſpeichern, *to garner for future use.*

It indicates to "begin to do a thing" in the compound aufſpielen, *to strike up, begin to play*, from ſpielen, *to play.*

Aus.—This has the meaning of "out," "out of." Thus: gehen, *to go*, ausgehen, *to go out*; ſchreiten, *to step*, ausſchreiten, *to step out*; ſprechen, *to speak*, ausſprechen, *to speak out, express.*

It denotes "selection" in the following: nehmen, *to take*, ausnehmen, *to except*; leſen, *to gather*, ausleſen, *to select.*

It denotes "carrying the action of the simple verb to its completion." Thus: blaſen, *to blow*, ausblaſen, *to blow out*; halten, *to hold*, aushalten, *to hold out, endure*; tönen, *to sound*, austönen, *to cease to sound.*

Bei.—This has two main meanings, "beside" or "with," and "aside." It denotes "addition" or "help." Thus: treten, *to tread*, beitreten, *to join with*; bringen, *to bring*, beibringen, *to adduce, to administer* (food or medicine), *to impart*; ſtehen, *to stand*, beiſtehen, *to stand by, to assist*; ſtimmen, *to vote*, (einem) beiſtimmen, *to agree with* (someone).

It denotes "aside" in ſetzen, *to place*, beiſetzen, *to deposit, bury*; legen, *to lay*, beilegen, *to lay aside.*

Da or Dar.—This indicates "in the presence of an onlooker." Thus: bieten, *to offer*, darbieten, *to hold forth, to present*; legen, *to lay*, darlegen, *to expose, to display.*

Ein.—This usually means "in" or "into." Thus: biegen, *to bend*, einbiegen, *to bend in, to turn in*; fließen, *to flow*, einfließen, *to flow in* or *into*; legen, *to lay*, einlegen, *to put in, to inlay*; laſſen, *to let*, einlaſſen, *to let in, admit.*

It intensifies the action of the verb when this expresses collection. Thus: kaſſieren, *to receive* (money), einkaſſieren, *to receive and put away* (money); ernten, *to harvest*, einernten, *to get in harvest.*

It denotes "coming to an end" in the following: gehen, *to go*, eingehen, *to be discontinued*; ſtellen, *to place*, einſtellen, *to discontinue.*

Empor.—This always means "up" or "upwards." Thus: kommen, *to come*, emporkommen, *to rise*; heben, *to lift*, emporheben, *to raise up, to uplift.*

Fort.—This means "onwards" or "away." Thus: fahren, *to go* or *drive*, fortfahren, *to go away* or *to continue*; kommen, *to come*, fortkommen, *to get away* or *to get on*; treiben, *to drive*, forttreiben, *to drive away.*

Her.—The ordinary meaning of this is "hither." Thus: laufen, *to run*, herlaufen, *to run* (in the direction of the speaker).

It sometimes denotes origin. Thus: rühren, *to move*, herrühren, *to originate*, ſtammen, *to spring, to descend*, herſtammen, *to descend.*

It is used for "repeating a lesson, poem," etc. Thus: ſagen, *to say*, herſagen, *to recite*; ſingen, *to sing*, herſingen, *to sing* or *recite in a sing-song way.*

It has a good many idiomatic uses. Thus: ſtellen, *to place*, herſtellen, *to restore*; nehmen, *to take*, hernehmen, *to take from* or *out of*; geben, *to give*, hergeben, *to give up, to yield.*

Hin.—The usual meaning of this is "thither." Thus: gehen, *to go*, hingehen, *to go* (away from the speaker).

It intensifies the action in composition with verbs denoting a downward motion. Thus: ſinken, *to sink*, hinſinken, *to sink to the ground*; fallen, *to fall*, hinfallen, *to fall down.*

It denotes "continuance." Thus: halten, *to hold*, hinhalten, *to hold in suspense*; brüten, *to brood*, hinbrüten, *to continue to brood.* Akin to this is its meaning of "along," when compounded with certain verbs of motion. Thus: ſchlendern, *to dawdle*, hinſchlendern, *to dawdle along*; rauſchen, *to rustle*, hinrauſchen, *to rustle along.* It is specially used with verbs denoting killing. Thus: richten, *to condemn*, hinrichten, *to execute*; ſchlachten, *to slaughter*, hinſchlachten, *to butcher.*

It also has a number of idiomatic uses. Thus: gehören, *to belong*, hingehören, *to belong to*; horchen, *to listen*, hinhorchen, *to listen to*; geben, *to give*, hingeben, *to yield*; nehmen, *to take*, hinnehmen, *to receive*; ſchreiben, *to write*, hinſchreiben, *to write down.*

VOCABULARY

Erlkönig, s.m.2, *elf king.*
Knabe, w.m., *boy.*
faſſen, w., *to grasp.*
halten, s., *to hold.*
bergen, s., *to hide.*
Geſicht, s.n.3, *face.*
Streif(en), w.m., *strip, streak.*
bunt, *bright, multi-coloured.*
gülden, *golden.*
leiſe, *quiet, soft, gentle.*
dürr, *dry.*
ſäuſeln, w., *to rustle.*
warten, w., *to tend.*
nächtlich, *nightly, by night.*
tanzen, *to dance.*
Ort, s.m.2, *place, spot.*
ſcheinen, *to shine, gleam*, s.
grau, *grey.*
Geſtalt, w.f., *shape, form, figure.*
brauchen, w., *to use.*
an'faſſen, w., *to seize.*
grauſen, w. (impers.), *to be afraid.*
ächzen, w., *to groan.*
Hof, s.m.2, *court, house.*
Not, w.f., *danger, distress.*
reiten, s. *to ride.*
Arm, s.m.2, *arm.*
ſicher, *safe.*
warm, *warm.*
bang, *fearful, afraid.*
Nebel, s.m.1, *fog, mist.*
gar (adv.), *very, most.*
Spiel, s.n.2, *game.*
Strand, s.m.2, *shore.*
Gewand, s.n.3, *robe, vesture.*
verſprechen, s., *to promise.*
Blatt, s.n.3, *leaf.*
fein, *fine, pretty.*
Reihn, s.m.1, *song and dance.*
ein'wiegen, w., *to rock to sleep.*
düſter, *dark, gloomy.*
genau, *exact.*
Weide, w.f., *willow.*
reizen, w., *to attract, allure.*
willig, *willing.*
Gewalt, w.f., *force.*
Leids, s.n., *injury.*
geſchwind, *quick.*
erreichen, w., *to reach.*
Mühe, w.f., *trouble.*

Exercise 47

Erlkönig.

Wer reitet ſo ſpät durch Nacht und Wind?
Es iſt der Vater mit ſeinem Kind;
Er hat den Knaben wohl in dem Arm,
Er faßt[1] ihn ſicher, er hält ihn warm[2].

Mein Sohn, was[3] birgſt du ſo bang dein Geſicht?—
Siehſt, Vater, du den Erlkönig[4] nicht[5]?
Den Erlenkönig mit Kron' und Schweif?—
Mein Sohn, es iſt ein Nebelſtreif.—

„Du liebes Kind, komm[6], geh mit mir,
Gar ſchöne Spiele ſpiel' ich mit dir;
Manch' bunte Blumen ſind an dem Strand,
Meine Mutter hat manch' gülden Gewand."—

Mein Vater, mein Vater, und höreſt du nicht,
Was Erlenkönig mir leiſe verſpricht?—
Sei ruhig, bleibe ruhig, mein Kind.
In dürren Blättern ſäuſelt der Wind.—

„Willſt, feiner Knabe[8], du mit mir gehn?
Meine Töchter ſollen dich warten ſchön;
Meine Töchter führen[9] den nächtlichen Reihn
Und wiegen[7] und tanzen[7] und ſingen[7] dich ein[10]."

Mein Vater, mein Vater, und ſiehſt du nicht dort.
Erlkönigs Töchter am düſtern Ort?—
Mein Sohn, mein Sohn, ich ſeh' es genau:
Es ſcheinen die alten Weiden ſo grau.—

„Ich liebe dich, mich reizt deine ſchöne Geſtalt;
Und biſt du nicht willig, ſo brauch[7] ich Gewalt."
Mein Vater, mein Vater, jetzt faßt er mich an!
Erlkönig hat mir ein Leids[11] getan.—

Dem Vater grauſet's; er reitet geſchwind,
Er hält in den Armen das ächzende Kind,
Erreicht den Hof mit Mühe und Not;
In ſeinen Armen das Kind war todt.

J. W. von Goethe.

NOTES:

(1) faßt ihn ſicher; translate *holds him securely.* (2) warm halten, is *to keep warm.* (3) was, in the sense of warum. (4) Erlkönig, erl is supposed to come from a Norse word meaning *elf*; in the compound Erlenkönig, we have a weak gen. in the first word of the compound. (5) nicht—the position at the end makes it doubly emphatic. (6) komm—this imperative is used much as "come" is used in English, when trying to persuade someone to do something. (7) ſpiel'—the present used for the future. (8) feiner Knabe; this is placed parenthetically between willſt and the pronoun du. (9) führen, einen Reihn führen, is *to dance and sing at the same time.* (10) ein properly only goes with the first verb wiegen, but it is extended to the other two verbs here. (11) Leids, the ordinary form of this word is Leid.

VOCABULARY

truth, Wahrheit, w.f.
acknowledge, anerkennen, s (sep.).
possession, Beſitz, s.m.
be in want of, nötig haben.
however, wie . . . auch.
feeling, Gefühl, s.n.2.
consider, anſehen, s (sep.).
rightful, unſtreitbar.
some one or other, irgend ein.
let, vermieten, w.
return, fortfahren, s.
make an answer, Antwort (w.f.) geben, s.
from, aus.
England, England, s.m.
chaise, Wagen, s.m.1.
see, beſichtigen, w.
agree, übereinkommen, s (sep.).
immediately, ſofort.
Michaelmas, Michaelis.
next, nächſt.
universally, allgemein.
single (unmarried), ledig.
fortune, Vermögen, s.n.1.
wife, Frau, w.f.
know, wiſſen, s.
neighbourhood, Gegend, w.f.
family, Familie, w.f.
property, Eigentum, s.n.3.
dear, lieb.
answer, erwiedern, w. antworten, w.
just, eben.
to have no objection, nichts dagegen haben.
north, Norden, s.m.
come down, herkommen, s (sep.).
place, Wohnſitz, s.m.2.
delight, gefallen, s. (impersonal) gov. dat.
take possession, im Beſitz treten, s.
servants, Dienſtleute.

Exercise 48

It is a truth universally acknowledged[1] that a single man in possession of a good fortune must[2] be in want of a wife. However[3] little known the feelings of such a man may be on his first entering a neighbourhood,[4] he is considered, by[5] the surrounding[6] families, as the rightful property of some one or other of their daughters.

"My dear Mr.[7] Bennet," said his wife to him one day,[8] "have you[9] heard that Netherfield Park is let at last?"

Mr. Bennet answered that he had not.[10]

"But it is,"[11] returned she; "for Mrs. Long has just been here, and she told me all about it."[12]

Mr. Bennet made no answer.

"Do you want[13] to know who has taken it?" cried his wife impatiently.

"You want[14] to tell me, and I have no objection to hearing[15] it."

"Why,[16] my dear, you must know.[17] Mrs. Long says that Netherfield is taken[18] by a young man of large fortune from the North of England; that he came down on Monday in a chaise and four[19] to[20] see the place, and was so much delighted[21] with it, that he agreed with Mr. Morris immediately; that he is[22] to take possession before Michaelmas, and some of his servants are to be[23] in the house by[24] the end[25] of next week."

Jane Austen.

NOTES:

(1) It . . . acknowledged; say, it is universally acknowledged as truth. (2) must be; say, is. (3) however . . . known; say, however little one may know of. (4) on . . . neighbourhood; say, when (wenn) he settles (ſich niederlaſſen) in a neighbourhood. (5) by here, von. (6) surrounding; say, of the neighbourhood (Nachbarſchaft, s.f.). (7) omit "Mr." (8) one day; use the adverbial genitive. (9) you; use the familiar du. (10) had not; supply "heard it" after this, and use the Past Conj. of *to have* to indicate reported speech. (11) it is; say, it is the case (der Fall, s.m.2). (12) omit "about it." (13) do you want, willſt du. (14) you want; insert gern here. (15) hearing; use the infinitive. (16) why, here, aber. (17) know; supply "it" after "this." (18) is taken; turn this into the active voice, i.e. a young man has taken Netherfield. (19) four; supply "horses" (Pferd, s.n.2) after this. (20) to, um. (21) say, it has delighted him so well (gut). (22) is to, ſollen. (23) to be in the house; say, to move in (einziehen, s. sep.). (24) by; instead of this say, ſchon. (25) end; use the accusative without any article.

Key to Exercise 45

THE SUN AND THE MOON

From the council of the Eternal the creative voice went forth: "Two Lights shall shine in the firmament as kings of the earth, arbiters of rolling time."

He spoke and it was so. Up rose the sun, the first light. As a bridegroom steps forth in the morning from his chamber, as a hero looks forward to his victorious career: thus he stood, clad in God's glory. A wreath of all colours shone (flowed) round his head; the earth was jubilant, its herbs gave forth a sweet scent, the flowers decked themselves.

The other light stood there enviously, and saw that it could not outshine his splendour. "What is the use of two princes on one throne?" it said, muttering to itself, "Why was it my fate to be the second and not the first?" And suddenly its light vanished, expelled by inward grief. It flowed away from it, far into the air, and became the host of the stars. Pale as a corpse Luna stood there, humiliated before all the heavenly ones, and wept: "Have mercy, Father of Life, have mercy."

And God's angel stood before her dark form (the dark one); and spake to her the sacred word of doom: "Because thou hast envied the light of the sun, unhappy one, thou shalt henceforth only shine with his light; and when yonder earth steps before thee, thou shalt stand half or wholly obscured as now. But, child of error, do not weep. The Merciful one has forgiven thee thy fault, and has transformed it into good. 'Go,' said He, 'comfort the repentant sinner (one). She too in her brilliance shall be a queen. The tears of her repentance shall be balm which refreshes all that languishes, which quickens with new strength all that is wearied by the sun's rays.'"

Luna, comforted, turned away; and behold! that brilliance surrounded (flowed round) her in which she still shines. She started upon the path which she still pursues, queen of the night, the leader of the stars. Bewailing her sin, pitiful to every tear, she seeks those whom she may revive, those whom she may comfort.

Key to Exercise 46

Alexanders Enthaltſamkeit.

Alexander der Große kam auf ſeinem Zuge die Welt zu erorbern, durch eine Wüſte Aſiens, in der ſich nirgends Waſſer befand. Endlich hatte ein Soldat etwas aufgefunden, und brachte es in ſeinem Helm dem Alexander. Da dieſer aber ſah, daß ſeine Soldaten eben ſo ſehr nach Waſſer lechzten wie er, ſprach er: „Soll ich der Einzige ſein der da trinkt?" und goß das Waſſer auf die Erde. Alle, voll Bewunderung über die Enthaltſamkeit des Königs, riefen: „Auf! Führe uns weiter; wir ſind nicht ermattet, wir ſind nicht durſtig. Wir halten uns nicht für ſterblich wenn ein ſolcher König uns führt."

M. A. L.

Continued from page 358.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D., Cyril J. Silverston, B.Sc.(Lond.).

NORTH AMERICA.—III

POLITICALLY the subdivisions of North America are very simple. With the insignificant exception of a few islands that belong to France, and the Danish settlements in Greenland, the whole of the continent is divided between three powers. These are Great Britain and the republics of the United States and Mexico.

The possessions of Great Britain comprise the northern half of the continent with the exception of Alaska and consist of the Dominion of Canada and Newfoundland. The latter colony includes a more or less indefinite portion of the coastal belt of the province of Labrador. While it should be remembered that Newfoundland is a self-governing colony entirely separate from the Dominion of Canada, it will be convenient to consider the British possessions of North America as a whole.

The Dominion of Canada

The boundaries of Canada are, on the north the Arctic Ocean, on the east the Atlantic Ocean, on the west Alaska and the Pacific Ocean, and on the south the United States.

The boundary between Canada and Alaska consists of the 141st Meridian W. of Greenwich from the Arctic Ocean as far as Mt. St. Elias. Thence it follows the coast-line at a distance of a few miles from the sea as far as Prince of Wales Island in latitude 54° 40′ N. Between Canada and the United States the boundary consists of the 49th parallel of latitude until this reaches the Lake of the Woods. Thence it follows the Pigeon and Rainy Rivers and the line of the Great Lakes and the St. Lawrence River until this crosses the 45th parallel. From here it follows the 45th parallel as far as longitude 71° 30′ W., when the boundary line has a complicated course meeting the Atlantic Ocean at the mouth of the St. Croix River between New Brunswick and the State of Maine, in the United States.

The total area of Canada is about 3,730,000 square miles of which no less than 125,750 are water. The population is over 8,500,000, of which over 100,000 are native Indians and Eskimos.

In many parts of eastern Canada, especially in the province of Quebec, the inhabitants comprise a large proportion of French-Canadians, descendants of the French in Canada in the year 1763, in number about 1,600,000. By statute, French is an official language in the Dominion Parliament and also in the province of Quebec, but English is spoken and understood practically everywhere.

Timber Trade

Politically Canada is divided into eleven provinces which we will discuss in groups according to their natural physical characteristics.

On the east we have the maritime provinces and the district surrounding Hudson Bay. The rivers which flow either into the St. Lawrence or into Hudson Bay are invaluable as affording a cheap method of transport for timber which is the chief industry of the whole district. The water power developed by the streams is used for saw-mills, and the rivers themselves, especially when swollen in the springtime after the thaw, are used to float down the huge rafts of logs and squared timber to the ports whence it can be shipped in sea-going vessels.

The largest saw-mills in the Dominion are at Ottawa, the capital city. The lumber and wood-pulp industry is mostly carried on in the south in the provinces of Ontario, Quebec and New Brunswick. An extensive lumbering industry is also carried on in other parts of the Dominion—notably in British Columbia — which alone produces some 900 million feet of timber annually.

In parts of New Brunswick and Prince Edward Island dairy farming is extensively carried on; and the orchards of Nova Scotia round the Bay of Fundy are famous throughout the world.

CHEAP TRANSPORT IN CANADA.

Rivers are largely used to float down timber from the wealthy forest lands to the saw-mills. This method of transport is employed especially in the spring-time when the rivers are swollen after the thaw and when therefore log jams—such as that shown above on the Montreal River—are less likely to occur.

In what is known as the Lake Peninsula of Ontario, owing to the rich pastures, stock-breeding is largely followed and cereal crops are grown.

In the north, hunting and trapping fur-bearing animals is the chief occupation of the Eskimos and Indians who live there. The principal animals sought for are bears, fox, beaver, marten and ermine, the skins of which are either sold or bartered for other commodities. New Brunswick and Nova Scotia have also important fishing industries, St. John and Halifax being the chief centres, both of them important ports. Coal is found in Nova Scotia and a good deal of silver in Ontario. Nickel and copper are mined at Sudbury near Lake Huron.

Wheat Growing Regions

West of the district we have just considered is the wheat growing region of Manitoba and Saskatchewan. The southern portion of this district is drained by the rivers flowing into Lake Winnipeg, the principal being the Saskatchewan and the Red River. The valleys of both these rivers are floored with a black fertile soil, that of the Red River being particularly prolific. Although the rainfall of this region is rather scanty, yet as it comes in the early summer when most wanted, the deficit is not, as might have been expected, a bar to the successful cultivation of wheat. The seed is sown in the late spring after the frosts have ceased and the grain is stored in " elevators " until required for shipment, etc. The centre of the industry is the town of Winnipeg—the capital of Manitoba—and the whole district is served by three great lines of railway, the Canadian-Pacific, the Grand Trunk and the Canadian Northern.

Farther west in the province of Alberta cattle rearing is largely carried on, the centre being Calgary.

The northern parts of the provinces of Manitoba, Saskatchewan, Alberta and the North-West Territory drain principally into the Arctic Ocean. The country consists of Tundra and the " Barren Lands " in the north, with an afforested region merging into the wheat district which itself is almost entirely devoid of forests.

The westernmost province of the Dominion is British Columbia, a district of mountains, lakes and rivers. Excepting in the north-east all the rivers flow into the Pacific Ocean, the chief of them being, as has been mentioned above, the Fraser and the Columbia.

The lakes of British Columbia are characterised by their great length and small breadth, filling as they do deep troughs in the river valleys. As an instance, François Lake, the source of the Fraser, is nearly 60 miles long, but its average breadth is only one and a-half miles.

Owing to the warm ocean currents of the Pacific the climate of British Columbia is much milder than in districts on the eastern side of the continent situated in the same latitude, and fruit growing is largely carried on in the delta of the Fraser and in the inland valleys.

The mineral wealth of British Columbia is enormous, coal being fairly extensively mined, while gold, silver, copper, lead and other metals are found in many parts. Valuable sources of timber exist in different regions of the province, especially on the plains round the coast and in Vancouver Island where the Douglas Fir (or Oregon Pine, a superb specimen of which 210 feet was erected as a flagstaff in Kew Gardens, 1919) and the giant Hemlock are very abundant.

In the Fraser River especially, but also in all the other streams, valuable fisheries occur, salmon particularly being a noted product.

The capital of the province is Victoria, on Vancouver Island, the city of Vancouver on the mainland being the terminus of the Canadian-Pacific Railway.

Klondyke Gold Fields

The coast-line of British Columbia possesses a fiord-like character, and it is protected by a chain of islands which are really a submerged mountain range. The coast, however, from latitude 55° N. up to the boundary of the province belongs to Alaska.

To the north of British Columbia is Yukon, a mountainous and barren province containing the Klondyke district, famous for the phenomenal discoveries of gold in the year 1896. In 1910 no less than four and a half million pounds worth of the precious metal were produced from this region. Coal has also been found in the same district.

The capital of Yukon is Dawson on the river Yukon, which latter is navigable in summer for river steamers from the mouth beyond Dawson to the junction of the Pelly River. In Yukon are some of the highest mountains of the continent, Mt. Logan, 19,000 feet, and Mt. St. Elias, 18,000 feet.

The colony of Newfoundland is an island situated at the mouth of the Gulf of the St. Lawrence. Although a great part of it is barren there are fertile districts in the river

valleys and on the borders of the lakes with which the island is plentifully supplied. The climate is warmer than that of the mainland owing to the influence of the Atlantic, but it is very subject to fogs.

Coal and iron are found, the latter of which is extensively mined and the ore taken to Cape Breton Island to be smelted. But the most important of the industries is undoubtedly that of the fisheries, the most famous area being the waters over a submarine plateau known as the Great Bank lying to the south-east of Newfoundland. The fishing on the Great Bank is free to all nations; in the territorial waters the French alone, besides the British, enjoy certain rights. They possess the small islands of St. Pierre and Miquelon.

Cities of Canada

The capital of Newfoundland is St. John's which has a fine harbour and is the centre of the fishing trade.

The population of Canada is chiefly concentrated in the eastern provinces, Quebec and Ontario having the largest number of inhabitants, though Prince Edward Island, Nova Scotia and New Brunswick have the largest population per square mile. The most important cities are Ottawa, the capital of the Dominion in the province of Quebec, Toronto, Quebec and Montreal, which last is the most populous, and commercially the most important city.

Transport System

The canal system of Canada enables goods to be shipped by water from Lake Superior to Montreal at the head of the ocean navigation avoiding the rapids and waterfalls on the rivers. But besides these canals there are many others of hardly inferior importance. All three railways of the chief trunk lines cross the Rocky Mountains by various passes, and the Canadian-Pacific Railway forms an important link in the communications of the Empire.

The chief exports are grain, live stock, timber, wood-pulp, fish, gold, silver and lead ores, fruit and dairy produce. The imports are chiefly woollen and cotton goods, iron and steel manufactures, tobacco. C. J. S.

By permission of the Canadian-Pacific Railway.

WINNIPEG, THE CAPITAL OF MANITOBA,

and the centre of a great wheat-growing district which is served by three lines of railway, the Canadian-Pacific, Grand Trunk, and Canadian Northern.

Continued from page 365.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A.[Lond.]).

ALGEBRA.—XXII

132. Harmonic Progression.

A series of quantities is said to be in **Harmonic Progression** (H. P.) when the reciprocals are in arithmetical progression

Thus $1, \frac{1}{3}, \frac{1}{5}, \frac{1}{7}$ . . . . is an H. P., for 1, 3, 5, 7 are in A. P.

If a, b, c be in H. P. then by definition $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in A. P.

$$\therefore \frac{1}{b} - \frac{1}{a} = \frac{1}{c} - \frac{1}{b} \quad \therefore \frac{a-b}{b-c} = \frac{a}{c}$$

This relation is often given as a definition of an H. P.

Further, since $\frac{1}{b} - \frac{1}{a} = \frac{1}{c} - \frac{1}{b}$

$$\therefore b = \frac{2ac}{a+c}$$

Thus the Harmonic Mean between two quantities is twice their product divided by their sum.

We may deduce a relationship between the Arithmetic, Geometric and Harmonic Means of two quantities.

If A = Arithmetic Mean of a and b
G = Geometric Mean of a and b
H = Harmonic Mean of a and b

then $A = \frac{a+b}{2}$, $G = \sqrt{ab}$, $H = \frac{2ab}{a+b}$

$$\therefore A \times H = G^2$$

$$\therefore G = \sqrt{A.\ H.}$$

Thus

The Geometric Mean of two quantities is also the Geometric Mean of their Arithmetic and Harmonic Means.

To insert n Harmonic Means between any two quantities a and b, we insert n Arithmetic Means between the quantities $\frac{1}{a}$ and $\frac{1}{b}$.

These will be $\frac{1}{a} + \frac{1}{n+1}\left(\frac{1}{b} - \frac{1}{a}\right)$, $\frac{1}{a} + \frac{2}{n+1}\left(\frac{1}{b} - \frac{1}{a}\right)$, ... $\frac{1}{a} + \frac{n}{n+1}\left(\frac{1}{b} - \frac{1}{a}\right)$

Simplifying these and inverting them, we get the harmonic means

$$\frac{(n+1)ab}{nb+a}, \quad \frac{(n+1)ab}{(n-1)b+2}, \quad \ldots\ldots\ldots, \quad \frac{(n+1)ab}{b+na}.$$

No formula can be found for the sum of any number of terms of an H. P.

Exercise 32

(1) Find the 8th term of the series $1\frac{1}{3}, 1\frac{1}{17}, 2\frac{2}{13}$ . . . . .

(2) Find the nth term of an H. P. whose first two terms are 3 and 6.

(3) Insert two Harmonic Means between 4 and 12.

(4) Insert three Harmonic Means between 2 and 8.

(5) If a, b, c be in A. P. and b, c, d be in H. P. show that $a : b = c : d$.

(6) If x, y, z be in H. P. show that $\frac{y+x}{y-x} + \frac{y+z}{y-z} = 2$.

(7) If x, a_1, a_2, y be in A. P., x, g_1, g_2, y be in G.P. and x, h_1, h_2, y be in H. P. show that $\frac{g_1 g_2}{h_1 h_2} = \frac{a_1 + a_2}{h_1 + h_2}$

(8) Find three numbers in G. P. such that if each is increased by 18 they are in H. P., and if the last is diminished by 24 they are in A. P.

(9) If L, M, N be respectively the lth, mth, and nth terms

(1) of an A. P. (2) of a G. P. (3) of an H. P. show that

(1) $L(m-n) + M(n-l) + N(l-m) = 0$

(2) $L^{m-n} \cdot M^{n-l} \cdot N^{l-m} = 1$

(3) $MN(m-n) + NL(n-l) + LM(l-m) = 0$.

133. Permutations and Combinations.

The different ways in which r things can be selected from n things, *without any reference to the order in which the r things are arranged*, is called a **combination of *n* things taken *r* at a time,** and is written ${}_nC_r$.

The different ways in which r things can be taken from n things, *when every possible order of arrangement of the r things is considered* is called a **Permutation of *n* things taken *r* at a time,** and is written ${}_nP_r$.

In counting the permutations and combinations of given things, we may represent them by letters, either all different, or partly alike, according as the things considered are all different, or partly alike.

Consider four different things represented by the letters a, b, c, d.

The combinations of these that can be formed if we take 3 at a time, are: *abc, bcd, cda, dab.* Thus 4 different combinations can be formed of 4 things taken 3 at a time.

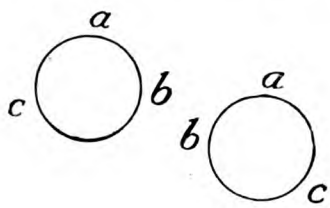
The number of permutations that can be formed is, however, far larger, for if we take the arrangement of the things into account, *abc* is clearly different from *bac, cba,* etc.

The permutations that can thus be formed are

abc acb bac bca cab cba
bcd bdc cbd cdb dbc dcb
cda cad dca dac acd adc
dab dba abd adb bad bda

Thus 24 different permutations can be formed of 4 things taken 3 at a time.

We have treated the permutations as if the things we arranged in a row or a line open at both ends; we must now examine what would happen if the things were arranged in a circle or other closed curve.



Consider the two permutations in accompanying diagram. If any distinction is made between clockwise and counterclockwise order, there are two distinct permutations. If, however, no such distinction is made, the two diagrams represent only one permutation, and consequently in such a case we have only half the number of permutations we should otherwise get.

134. *To find the number of permutations of n different things taken r at a time.*

Suppose we take r boxes in a row, and make our different permutations by filling these boxes in all possible ways, always placing one thing in each box. Since we have n different things, we can clearly fill the first box in n different ways. Having filled the first box in any one way, we shall have $n - 1$ things left from which to fill the second box, and consequently we can fill the second box in $(n - 1)$ different ways. Thus combined with each way in which the first box is filled, we have $n - 1$ ways of filling the second box, and therefore the total number of ways in which the first and second boxes can be filled is $n(n - 1)$. When the first and second boxes are filled, there are $n - 2$ ways of filling the third, and by the same process of reasoning we see that the total number of ways in which the first, second and third boxes can be filled is $n(n - 1)(n - 2)$. Proceeding thus we find that the total number of ways in which the r boxes can be filled is $n(n-1)(n-2)(n-3) \ldots\ldots (n-r+1)$.

Thus ${}_nP_r = n(n - 1)(n - 2)(n - 3) \ldots\ldots (n - r + 1)$.

The right-hand side of this equation consists of r factors, the first being n, and the next $(r - 1)$ factors being successive integers, each less by unity than the preceding one.

Thus ${}_4P_3 = 4 \cdot 3 \cdot 2 = 24$, the result we arrived at by actually writing out the permutations before.

From the above we see that the number of permutations of n different things taken n at a time $= {}_nP_n = n(n-1)(n-2) \ldots 3 \cdot 2 \cdot 1$.

The product $n(n-1)(n-2) \ldots\ldots 3 \cdot 2 \cdot 1$. is called **factorial** n and is written $n!$

135. *To find the number of permutations of n things taken all together, when the things are not all different.*

Let us represent the number of permutations by P; let the n things be represented by letters a, b, c, etc., and suppose p of them to be a's, q of them to be b's, r of them c's, and so on.

If in any single permutation, the a's were changed into p letters all different from each other and from all the rest, then by merely altering the arrangement of these p letters instead of one permutation we should have $p!$ permutations.

Thus if the a's were all changed in the way indicated above, and the b's, c's and so on remained unaltered, we should have $P \times p!$ permutations.

If now all the b's were also changed into q different letters, all differing from each other and the rest, we should have $P \times p! \times q!$ permutations.

Proceeding thus we should arrive at $P \times p! \times q! \times r! \times \ldots\ldots$ permutations.

But the number of permutations of n different things taken all together is $n!$. And the p things represented by a's, the q things represented by b's, the r things represented by c's and so on, all together make up n things.

$$\therefore P \times p! \times q! \times r! \times \ldots\ldots = n!$$

$$\therefore P = \frac{n!}{p! \times q! \times r! \times \ldots\ldots}$$

136. Every circular permutation of things taken r at a time will give rise to r permutations of the things arranged in a row, since each of the r things may stand first in the row. On the other hand one permutation of r things taken at a time arranged in a row, will give rise to only one circular permutation. Hence there are r times as many permutations of things taken r at a time when they are arranged in a row, as there are permutations when the things are arranged in a circle. Hence the number of permutations of n different things taken r at a time, when the things are arranged in a circle, is $\frac{{}_nP_r}{r} = \frac{n(n-1)(n-2) \ldots\ldots (n-r+1)}{r}$

Examples:—

(1) In how many ways can the letters of the word "barracks" be arranged?

Here we have 8 different letters, but 2 of them are a's and two of them are r's.

$$\therefore \text{the number of permutations} = P = \frac{8!}{2!\ 2!}$$

$$= \frac{8.\ 7.\ 6.\ 5.\ 4.\ 3.\ 2.\ 1}{2.\ 1.\ 2.\ 1} = 10080 \text{ ways.}$$

(2) In how many ways can a party of 7 take their places round a table?

If the people sat in a row, the number of permutations would be ${}_7P_7 = 7!$; but since they sit practically in a circle, the number of permutations is $\frac{7!}{7} = 6!$

137. *To find the number of combinations of n things taken r together.*

If we take any one combination, we could make ${}_rP_r = r!$ permutations out of it (since in a combination the order of things is not regarded).

Therefore all the combinations of n things taken r together multiplied by $r!$ must equal the number of permutations of n things taken r together; i.e.

$${}_nC_r \times r! = {}_nP_r$$

$$\therefore {}_nC_r = \frac{{}_nP_r}{r!} = \frac{n(n-1)(n-2)\ldots(n-r+1)}{r!}$$

Multiplying the numerator and denominator of the fraction on the right by $(n-r)!$, we have

$${}_nC_r = \frac{n(n-1)(n-2)\ldots(n-r+1)(n-r)(n-r-1)\ldots.3,2,1.}{r!(n-r)!}$$

$$= \frac{n!}{r!(n-r)!}*$$

which is the most convenient form in which to express ${}_nC_r$

From the above it follows that ${}_nC_{n-r} = \frac{n!}{(n-r)!\{n-(n-r)\}!} = \frac{n!}{(n-r)!\,r!}$, and

$$\therefore {}_nC_r = {}_nC_{n-r}$$

Example:—

Out of a party of 5 women and 4 men a game of cards is to be arranged in which one woman and one man play against another woman and man. In how many ways can this be done?

The two women can be chosen in ${}_5C_2 = \frac{5!}{2!\,3!} = 10$ different ways; and the two men can be chosen in ${}_4C_2 = \frac{4!}{2!\,2!} = 6$ different ways.

Also each woman can have either of the two men chosen as a partner. Hence the number of ways in which this can be done is $10 \times 6 \times 2 = 120$.

133. *To find the greatest possible value of* ${}_nC_r$ *for a given value of* n.

$${}_nC_{r-1} = \frac{n!}{(r-1)!\,(n-r+1)!}$$

$$\therefore {}_nC_{r-1} \times \frac{n-r+1}{r} = \frac{n!}{r!(n-r)!} = {}_nC_r$$

Now since ${}_nC_r = {}_nC_{r-1} \times \frac{n-r+1}{r}$

$\therefore {}_nC_n = 1$ i.e. $\frac{n!}{n!\,0!} = 1$ and this can only be true if $0! = 1$

$$\therefore {}_nC_r \gtreqless {}_nC_{r-1} \text{ according as } n-r+1 \gtreqless r;$$

that is as $r \lesseqgtr \frac{1}{2}(n+1)$

Hence the number of combinations of n things r together increases as r increases so long as $r < \frac{1}{2}(n+1)$

If n be even then ${}_nC_r$ is greatest when $r = \frac{n}{2}$

If n be odd then ${}_nC_r \gtrless {}_nC_{r-1}$ as $r \lessgtr \frac{1}{2}(n+1)$ and when $r = \frac{1}{2}(n+1)$, ${}_nC_r = {}_nC_{r-1}$

In this case we see there are two equal values which are the greatest values of ${}_nC_r$.

Thus if $n = 12$, ${}_nC_r$ is greatest when $r = 6$.

* For the above formula to hold true when $r = n$ we must assume that $0! = 1$. Clearly the number of combinations of n things n together $= 1$.

But if $n = 15$, then when $r = 8$ we have ${}_nC_r = {}_nC_{r-1}$ and these values are greater than any others.

139. *To prove that* ${}_nC_r + {}_nC_{r-1} = {}_{n+1}C_r$

$${}_nC_r + {}_nC_{r-1} = \frac{n(n-1)\ldots\ldots(n-r+1)}{1,2,3,\ldots\ldots r} + \frac{n(n-1)(n-2)\ldots(n-r+2)}{1,2,3,\ldots\ldots(r-1)}$$

$$= \frac{n(n-1)(n-2)\ldots\ldots(n-r+2)}{1,2,3\ldots\ldots r}\{(n-r+1)+r\}$$

$$= \frac{(n+1)\,n\,(n-1)(n-2)\ldots(n-r+2)}{1,2,3\ldots\ldots r}$$

$$= {}_{n+1}C_r$$

140. Vandermonde's Theorem.

We will denote $a(a-1)(a-2)\ldots(a-r+1)$ by a_r, where r is an integer and a may or may not be an integer.

Vandermonde's theorem is the following:

$$(x+y)_n = x_n + {}_nC_1\,x_{n-1}\,y_1 + {}_nC_2\,x_{n-2}\,y_2 \ldots\ldots + {}_nC_r\,x_{n-r}\,y_r + \ldots\ldots + {}_nC_{n-1}\,x_1 y_{n-1} + y_n$$

Note that the general term ${}_nC_r\,x_{n-r}\,y_r$ is the $(r+1)$ the term.

The first term is given by putting $r = 0$ and is ${}_nC_0\,x_n\,y_0$

The last term is given by putting $r = n$ and is ${}_nC_n\,x_0\,y_n$

${}_nC_0$ and ${}_nC_n$ are interpreted as being $= 1$

and x_0 and y_0, which have no meaning, are also interpreted as being $= 1$. This gives us the two end terms.

Proof. $a_b\,(a-b) = a(a-1)(a-2)\ldots\ldots(a-b+1)(a-b)$

$$= a_{b+1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Again

$$(x_r) \times (y_s)\{(x-r)+(y-s)\} = x_r y_s\,(x-r) + x_r y_s\,(y-s)$$

$$= x_{r+1}\,y_s + x_r\,y_{s+1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

In the last article we showed that

$${}_nC_r + {}_nC_{r-1} = {}_{n+1}C_r \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

Assume Vandermonde's Theorem true for any particular value of n. We will prove that it is true for the next value of n.

Multiply each side by $(x+y-n)$. Then

$$(x+y)_n(x+y-n) = x_n\,(x+y-n) + {}_nC_1\,x_{n-1}\,y_1\,(x+y-n) + \ldots\ldots + {}_nC_r\,x_{n-r}y_r\,(x+y-n) + \ldots + {}_nC_{n-1}\,x_1\,y_{n-1}\,(x+y-n) + y_n\,(x+y-n) \ldots \text{(iv)}$$

By (i) $(x+y)_n(x+y-n) = (x+y)_{n+1}$ (putting $a = x+y$ and $r = n$) $\ldots\ldots\ldots\ldots$ (v)

By (ii) putting $r = n-r$, and $s = r$

$$x_{n-r}y_r\,\{x-(n-r)+y-r\} = x_{n-r+1}\,y_r + x_{n-r}\,y_{r+1}$$

i.e. $x_{n-r}y_r(x+y-n) = x_{n-r+1}\,y_r + x_{n-r}y_{r+1} \quad \ldots\ldots\ldots\ldots$ (vi)

(vi) enables us to work out all the terms of (iv) except the first and last.

Now $x_n(x + y - n) = x_n(x - n) + x_n y = x_{n+1} + x_n y_1$ and similarly
$y_n(x + y - n) = x y_n + y_{n+1}$

Hence each term in (iv) is the sum of 2 terms and we may write (iv) thus:

$$(x+y)_{n+1} = x_{n+1} + x_n y_1 + {}_nC_1 x_n y_1 + {}_nC_1 x_{n-1} y_2 + {}_nC_2 x_n y_2 + {}_nC_2 x_{n-1} y_2 + {}_nC_2 x_n y_3 + \ldots\ldots\ldots + {}_nC_{r-1} x_{n-r+2} y_{r-1} + {}_nC_{r-1} x_{n-r+1} y_r + {}_nC_r x_{n-r+1} y_r + {}_nC_r x_{n-r} y_{r+1} + \ldots\ldots\ldots + {}_nC_{n-1} x_2 y_{n-1} + {}_nC_{n-1} x_1 y_n + x_1 y_n + y_{n+1}$$

Adding terms of the same kind, we have by (iii)

$$(x+y)_{n+1} = x_{n+1} + {}_{n+1}C_1 x_n y_1 + {}_{n+1}C_2 x_{n-1} y_2 + \ldots\ldots\ldots + {}_{n+1}C_r x_{n+1-r} y_r \ldots + {}_{n+1}C_n x_1 y_n + y_{n+1}$$

Thus if the Theorem be true for any integral value n it is true for the next value $n + 1$.

But it is clearly true when $n = 2$ $\therefore$ it is true when $n = 3$, and $\therefore$ it is true when $n = 4$ and so on for all integral values of n.

Exercise 33

(1) Find the number of permutations that can be made from all the letters of the words: "phenomenon," "success," "uniformity."

(2) How many different integral numbers of 3 significant digits can be formed with the six digits 3 0 4 0 5 6.

(3) In how many ways can n things be put into m pigeonholes when there is no restriction as to the number of things that may be put into each?

(4) In how many ways can n different beads be strung on a string, if 2 particular beads are neither of them to be at either extremity?

(5) At an election there are three candidates and 12 electors. In how many different ways can they all vote?

(6) At a meeting there are 8 delegates from one town and 6 from another. In how many ways can they be seated at two tables, each having 7 seats, so that delegates from the same town do not sit next each other? The seats are on one side of the tables only.

(7) Given n different points no 3 of which are collinear, how many different straight lines can be drawn joining them? How many different triangles and quadrilaterals can be formed?

(8) Show that ${}_{4n}C_{2n} : {}_{2n}C_n$ as $\{1, 3, 5, 7 \ldots (4n-1)\} : \{1, 3, 5 \ldots\ldots (2n-1)\}^2$

Key to Exercise 29

(1) (*a*) 3 (*b*) 3 (*c*) 12. (2) (*a*) yz (*b*) $\frac{6b^3}{a}$ (*c*) $5y^2$. (3) (*a*) b (*b*) $12xy^2$ (*c*) a^2. (4) (*a*) ab (*b*) $6a^2x$ (*c*) $4\sqrt{2}\,ax$. (5) $\frac{29}{16}$. (6) 9, 12, 16.

Key to Exercise 30

(1) 27. (2) 10. (3) 16. (4) 50·26544 sq. in. (5) 0. (6) $\frac{2}{3}$.

Key to Exercise 31

(1) $34, 89\frac{1}{2}$. (2) 9, 16. (3) 1; $\frac{6n-1}{5}$. (4) $\frac{1}{2}$.

M. A. L.

GEOMETRY.—XX

Proposition 134.—Problem

To construct a regular pentagon in a circle.

Find the vertices of a regular decagon and join alternate vertices.

Or else proceed to find pts. A and B as in Prop. 133.

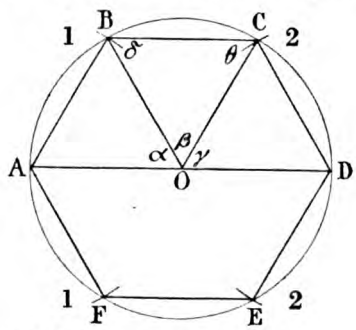
Cut off B C = A B. Join A C and mark off chords = A C to complete the figure.

$\angle$ A O C = 2 $\angle$ A O B = 2 × 36° = 72° = $\frac{1}{5}$ revolution.

= $\angle$ subtended at centre by regular pentagon.

Proposition 135.—Problem

To construct a regular hexagon in a given circle.



Let the circle have centre O.

Draw any diameter A O D.

With centre A and radius A O descr. ○ 1 to cut original ○ in B and F.

With centre D and radius D O descr. ○ 2 to cut original ○ in C and E.

Join pts. A and B, B and C, C and D, etc.

A B C D E F is required hexagon.

A O = A B = O B $\therefore$ $\triangle$ A O B is equilat.

Also $\triangle$ D O C is equilat.

$\therefore \alpha = \gamma = 60°$

$\therefore \beta = 60°$. ($\because \alpha + \beta + \gamma = 180°$)

Also $\delta + \theta = 120°$

but $\delta = \theta$ ($\because$ O B = O C)

$\therefore \beta = \delta = \theta = 60°$ i.e. $\triangle$ B O C is equilat.

Similarly $\triangle$ F O E is equilat.

$\therefore$ A B C D E F consists of 6 equilat. $\triangle$s.

$\therefore$ All the sides are equal and each $\angle$ at centre = 60° = $\frac{1}{6}$ of a revolution.

Proposition 136.—Problem

To construct a regular polygon of n sides in a *given circle.*

Draw any radius O A of given ○. With protractor draw from O radii making with O A $\angle$s α, 2α, 3α, 4α, etc., where $\alpha = \frac{360°}{n}$.

Draw the chords joining the extremities of the successive radii. They form the required polygon.

Proposition 137.—Problem

To describe a regular polygon of n sides about a given circle.

Draw radii as in Prop. 136 and produce them.

Draw one side of inscribed polygon.

Draw a tangent to ○ $\parallel$ to the side of the inscribed

polygon. This will cut two produced radii, and these pts. of intersection are angular pts. of the required polygon.

Draw a ⊙ concentric with the given ⊙ and passing through the two angular pts. just found.

This ⊙ will cut the other produced radii at the remaining angular points of the required polygon.

Proposition 138.—Problem

To inscribe a circle in a regular polygon.

The bisectors of the ∠s of the regular polygon are concurrent (this can easily be proved by the student).

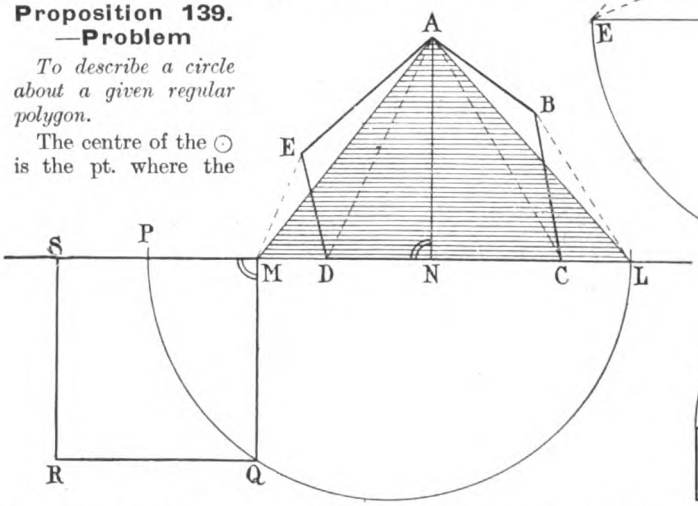
The pt. at which they meet is equidistant from the sides.

∴ ⊙ described with this pt. as centre and radius = ⊥ from this pt. on any side will be inscribed ⊙.

Proposition 139.—Problem

To describe a circle about a given regular polygon.

The centre of the ⊙ is the pt. where the bisectors of the ∠s meet, and its radius = distance of this pt. from any angular pt. of the regular polygon.



Proposition 140.—Problem

To describe a square equal in area to a given rectilineal figure.

Let A B C D E be the given rectilineal figure.

Reduce it to the △ A L M (Prop. 42).

Draw A N ⊥ to M L.

On L M produced cut off M P = ½ A N.

On P L as diameter describe a semi ⊙.

Draw M Q ⊥ to P L cutting the semi ⊙ in Q.

Complete the sq. M Q R S. This is required square.

Since M Q = ½ chord of ⊙ intersecting chord P L at M (for P L passes through centre and is ⊥ to M Q).

∴ M Q² = rect. P M . M L
= rect. ½ A N . M L
= area of △ M A L
= area of polygon A B C D E.

NOTE.—If the given rectilineal figure be a rectangle, we need only take M L = long side and P M = short side of rectangle.

Proposition 141.—Problem

To construct a figure similar to a given rectilineal figure and having its area equal to a given rectangle.

Let A B C D be the given rectilineal figure and I the given rectangle.

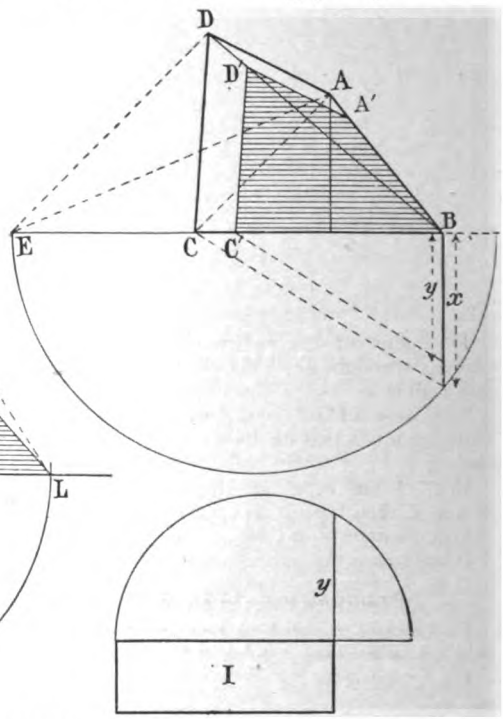
It is required to construct a fig. similar to A B C D and equal in area to I.

Reduce A B C D to the △ A E B, equal in area.

Find lengths x and y such that x^2 = area of △ A E B and y^2 = area of I (Prop. 140).

Cut off a length y from x.

Find pt. C′ in B C such that $\frac{B C'}{B C} = \frac{y}{x}$ (Prop. 127).



Complete the fig. B C′ D′ A′ similar to B C D A. Then B C′ D′ A′ is fig. required.

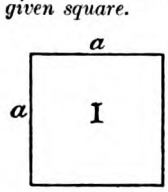
$$\frac{\text{area of B C' D' A'}}{\text{area of B C D A}} = \frac{B C'^2}{B C^2} = \frac{y^2}{x^2}$$

$$= \frac{\text{area of I}}{\text{area of B C D A}}$$

∴ area of B C′ D′ A′ = area of I.

Proposition 142.—Problem

To divide a given straight line internally so that the rectangle contained by its segments may equal a given square.

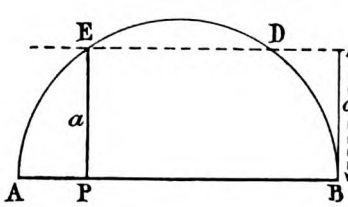


Let A B be the given str. line and I the given sq. of side a.

On A B describe a semi ⊙.

At a distance a from A B draw a line ‖ to A B cutting the semi ⊙ at D and E.

Draw a ⊥ from D or E to A B cutting it in P. P is the required pt.



Since A E B is a semi ⊙ rect. A P . P B = E P² = a^2 = I (Prop. 121).

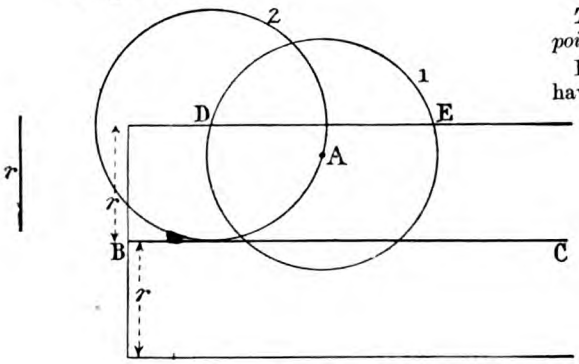
Proposition 143.—Problem

Describe a circle of given radius passing through a given point and touching a given straight line.

Let r be given radius.

A given pt.

B C given str. line.



The locus of the centre of all ⊙s of radius r passing through A is ⊙ 1 described with centre A and radius r.

The locus of the centre of all ⊙s of radius r touching B C is two str. lines ‖ to B C at a distance r from B C.

If ⊙ 1 cut either of these ‖ str. lines in pts. D and E, then both D and E are possible centres.

With centre D and radius r describe ⊙ 2.

It will pass through A and touch the line B C.

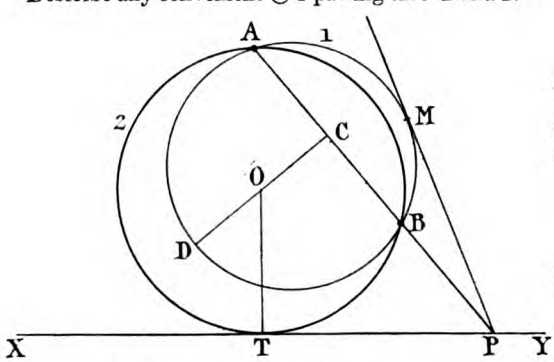
Proposition 144.—Problem

To describe a circle passing through two given points and touching a given straight line.

Let A and B be the given pts. and X Y the given str. line.

Join A B and produce to cut X Y in P.

Describe any convenient ⊙ 1 passing thro' A and B.



From P draw tangent P M to this ⊙.

From P X cut off P T = P M. From T draw a str. line ⊥ to X Y and let it cut the str. line C D drawn ⊥ to A B at the middle pt. of A B, in the pt. O.

Describe ⊙ 2 with centre O and radius O T.

This is required ⊙.

Proof.—P M touches ⊙ 1 ∴ P M^2 = rect. P B . P A. (Prop. 122)

∴ P T^2 = rect. P B . P A (∵ P T = P M)

∴ P T is a tangent to ⊙ passing through pts. T, A and B

∴ centre of this ⊙ lies on T O which is ⊥ to P T also centre of this ⊙ lies on ⊥ bisector of A B i.e. on C D.

But O is the pt. of intersection of these lines

∴ O is centre of ⊙ passing through T, A and B.

Proposition 145.—Problem

To describe a circle passing through two given points and touching a given circle.

Let A and B be the given pts. and 1 the given ⊙ having centre C.

Describe any convenient ⊙ 2 passing through A and B and cutting ⊙ 1 in D and E.

Let D E, A B produced meet in P.

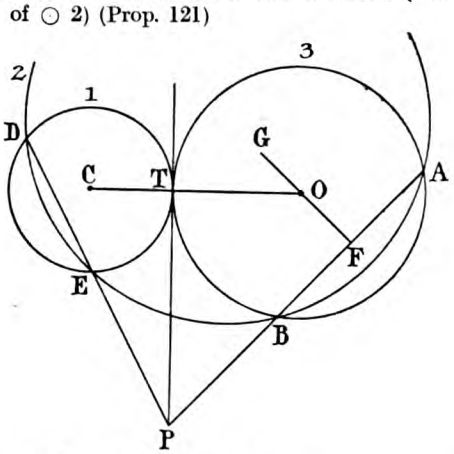
From P draw tangent P T to ⊙ 1.

Join C T and produce it to meet the ⊥ bisector F G of line A B in O.

With centre O and radius O T describe ⊙ 3. This is the required ⊙.

Proof.—P T touches ⊙ 1 ∴ P T^2 = rect. P E . P D (Prop. 122)

Rect. P E . P D = rect. P B . P A (secants of ⊙ 2) (Prop. 121)



∴ P T^2 = rect. P B . P A

∴ P T is tangent to ⊙ passing through A and B

∴ centre of this ⊙ lies on C T produced (∵ C T is ⊥ to P T)

and centre of this ⊙ lies on F G, ⊥ bisector of A B.

But O is pt. of intersection of C T and F G

∴ O is centre of required ⊙

i.e. ⊙ 3 passes through T, A and B.

Further, ⊙s 1 and 3 meet at T on the line joining their centres ∴ P T is tangent to ⊙ 3.

Exercise 23

(1) Describe a circle of given radius which shall touch two given circles.

(2) Describe a circle which shall pass through a given point and touch a given straight line at a given point.

(3) Given the base and vertical angle of a triangle, prove that the locus of the intersection of its medians is a segment of a circle.

(4) From an external point A tangents A B, A C are drawn to a circle whose centre is O. If O A meets the chord of contact at D, prove that the rectangle O A . O D is equal to the square on the radius.

(5) Describe a circle to touch two given straight lines and a given circle. M. A. L.

MECHANICS.—I*

1. MECHANICS is the name originally used to denote the science of building machines; it is now, however, used to denote the science of the motion and equilibrium of bodies.

The subject of Mechanics is generally subdivided into—

(*a*) **Dynamics,** which deals with the action of forces on bodies;

(*b*) **Kinematics,** which deals with the motion of bodies, and is entirely independent of the causes which produce such motion.

Dynamics is further subdivided into (*a*) **Statics,** which deals with bodies kept at rest, or in equilibrium, by the action of forces, and (*b*) **Kinetics,** which deals with the action of forces in producing or changing motion.

2. Force.—Our most direct perception of force is muscular force, and, what is more, muscular force which is impeded. If we stretch out our arm, we are not, as a rule, conscious of exerting force, but if in so doing our hand comes in contact with some heavy object which impedes the motion of the arm, we immediately feel that we are exercising force as we press against it.

If the object is not too heavy and we press sufficiently hard, we shall cause the object to *move*. This we do by the exertion of muscular force, and if any inanimate body tends to produce a similar result to one such as might be produced by muscular force, we say that that body is exercising force. Thus a steam engine exerts a force when propelling a train, just as a man exerts force when pushing a barrow.

Again, let us suppose we are keeping a door closed by pushing against it, while someone else is endeavouring to push it open from the other side, we shall again be conscious of exerting force, but this time the force is used to keep a body at rest, a body, moreover, which would be set in motion if we did not exert force on it.

Further, if a tennis ball comes flying over the net and we exert force on it by striking it with a racket, we shall change the direction of its motion.

Thus we see that force is always connected with motion. It tends to produce motion or to arrest motion; at any rate to change motion. Consequently we define *force* as *that which produces or tends to produce motion or a change of motion.*

Since, then, we see that force is intimately bound up with motion, we shall first turn our attention to the study of motion; that is, we shall begin with a course on kinematics. Before proceeding further, however, we shall do well to examine what we mean by motion and rest.

3. Motion.—When a body has one position in space at one time, and another position at another time, it is said to move. The idea of motion is familiar to all of us; we realise what it means when an apple falls from the tree to the ground, when a man walks along the street, when we watch the sun rising in the east and later on setting in the west. We always perceive motion by noting that a body is in one position in space at one moment of time, and at another position at another moment.

Thus we conclude that *motion* is a function of *space* and *time.*

Everyone is familiar with the ideas of space and time, and it is useless in a course of this description to attempt the exceedingly difficult task of defining them; nor shall we here concern ourselves with molecular motion such as is set up by heat, by electricity, and by chemistry, but shall confine ourselves to the motion of bodies as a whole and of particles.

A *particle* may be defined as the smallest quantity of any material which retains the physical and chemical properties of that material.

The student must realise that a particle is an ideal concept; you cannot separate a single particle from all the other particles which are together supposed to make up a body. A particle has no more real existence than a geometrical point.

There are different kinds of motion:

(*a*) *Translation.*—If a body moves from one place to another, it is said to undergo a motion of translation.

Thus if a train travels from London to Brighton, it undergoes translation.

Translation may be in a straight line—as, for instance, the fall of a heavy object dropped from a considerable height; or it may be in a curved line—as, for instance, the motion of the earth round the sun.

(*b*) *Rotation.*—When a body moves round a fixed point or axis, so that all points on the body describe concentric circles round the point or axis, the body is said to rotate.

Thus a wheel rotates on its axle.

The motion of rotation may be combined with that of translation—as, for instance, when a top which is spinning travels along the ground.

(*c*) *Wave Motion.*—This may be described as the movement of a particle to and from a particular point. When a series of neighbouring particles undergo a motion of this kind a wave or undulation is produced. The peculiarity of this form of motion is that the particles appear to the observer to undergo translation, though they each actually only move to and from a definite point. Everyone is familiar with wave motion on the sea, where the particles certainly appear to travel, whereas it is really the case that the motion itself travels to successive particles.

The student can convince himself of this by tying a rope or piece of string to two supports—the string must be rather slack—and then by jerking or pulling the string near one end, a wave motion can be imparted to the whole. The wave will travel from the point where the jerk is applied to either end of the string, but it is obvious that the individual particles only move to and from their original position, to which they return when the motion

* Students who are not familiar with Mathematics should not attempt this course until they have thoroughly studied the courses on Arithmetic and Geometry, and the course on Algebra up to and including the solution of Quadratic Equations. A knowledge of Trigonometry is helpful, but not essential.

has expended itself, and they do not undergo translation.

4. Rest.—Everyone is familiar with bodies that appear to be in a state of rest; but a little consideration will show that this state is merely apparent. Suppose we are travelling in a train, and opposite us in the carriage a man sits perfectly still. To all appearance he is at rest; yet we know that he is actually in motion, being carried along by the train.

Again, a house appears to us to be at rest, and it is at rest *relatively to the earth*; but the earth, as we know, is revolving round its own axis, it is also travelling round the sun, and further it is rushing, together with the rest of the solar system, through space. Thus we see that the house, though apparently at rest, is really undergoing three distinct motions. Hence we conclude that there is no such thing on earth as *absolute* rest, but that things may be at rest *relatively* to us or to the earth.

When, therefore, we speak of a body being at *rest*, we mean that its position *relative to its surroundings* does not change.

The body in motion is dealt with by Kinematics. We have next, therefore, to consider:

5. Velocity.—There are two properties of motion with which we shall have to deal. These are *speed* and *direction*. The term *velocity* is sometimes used for the former alone, but it is usually taken to include the two.

From what has been said above, we may define *motion* as *change of position*. Now when we consider motion with regard to the time taken in changing from one position to another, we get the idea of *speed*, *i.e.* of quickness or slowness of motion.

The direction must be given by referring to some known or fixed points, such as the points of the compass. When we say that a body travels N.E., then the direction of its motion is fixed.

When the speed and direction of a body in motion are known, then the velocity is known.

Velocity is defined as *the rate of change of motion*.

When a body moves through equal spaces in equal intervals of time, and in one and the same direction, it is said to have a *uniform velocity*, and its speed is said to be *constant*.

Thus a train travelling on a straight line may for some minutes pass through equal spaces in equal intervals of time. Its velocity is then said to be *uniform*, and its speed *constant*.

In all other cases the velocity is said to be *variable*.

Thus if we throw a stone into the air it will travel upwards for some time, but its speed will gradually diminish until the motion upwards ceases altogether; this motion will be immediately followed by one downwards, and the speed with which the stone falls will increase. In this case we see that the space passed through in equal intervals of time must vary, and moreover there is also a change of direction.

6. Velocity is measured by the distance travelled divided by the time taken to accomplish the change of position. Hence if a point move through a distance s in a time t, its velocity is $\frac{s}{t}$ or

$$V = \frac{s}{t}$$

Thus if a train travel 60 miles in 2 hours, its average speed is 30 miles an hour, or, as it is sometimes expressed, 30 miles per hour. This may be written in the following way:

$$\frac{60 \text{ miles}}{2 \text{ hours}} = \frac{30 \text{ miles}}{1 \text{ hour}} = 30 \times \frac{1 \text{ mile}}{1 \text{ hour}}$$

where $\frac{1 \text{ mile}}{1 \text{ hour}}$ stands for a speed of 1 mile per hour.

In the same way $\frac{1 \text{ foot}}{1 \text{ second}}$, or more shortly $\frac{\text{ft.}}{\text{sec.}}$ stands for a speed of 1 foot per second.

The *unit* of velocity is $\frac{\text{unit of length}}{\text{unit of time}}$.

The unit of time everywhere is the second; the unit of length in the British Isles is usually the foot, but on the Continent it is usually the centimetre.

Thus our unit of velocity is either $\frac{1 \text{ foot}}{1 \text{ second}}\left(\frac{1 \text{ ft.}}{\text{sec.}}\right)$ or $\frac{1 \text{ centimetre}}{1 \text{ second}}\left(\frac{1 \text{ cm.}}{\text{sec.}}\right)$

It is often convenient to express a speed given in miles per hour, or yards per minute and so on, in terms of the unit of speed.

To express a speed of 30 miles an hour as a speed of feet per second.

A mile contains 5,280 feet, and an hour contains 3,600 seconds.

In 3,600 seconds the distance travelled is $30 \times 5{,}280$ ft.

In 1 sec. the distance travelled is $\frac{30 \times 5280}{3{,}600}$ ft.

$= 44$ ft.

Hence a speed of 30 miles per hour is the same as a speed of 44 feet per second.

7. In § 6 we showed that $V = \frac{s}{t}$ where V is the average velocity.

If a body move with a uniform velocity, it is quite clear that its actual velocity v at any moment will also $= \frac{s}{t}$.

If, however, a body move with variable velocity, its actual velocity v at any particular moment might have any number of different values. For instance, the train which travels 60 miles in 2 hours, if it starts from rest, must obviously traverse less space in the first few seconds than it will do when going at full speed.

Again, since it cannot get up full speed at once, and takes some time to slow down before coming to a stop, it must obviously travel at a higher speed than 30 miles an hour during some portion of its journey.

The average velocity V is given by dividing the total distance covered by the total time taken; the actual velocity v can be found by dividing the small space traversed at any moment by the small interval of time taken to do so; and as the smaller

the space the less opportunity there will be for variation in speed, the most accurate measure of v at any instant is given by an infinitesimally small space divided by an infinitesimally small interval of time.

Thus the equation $v = \frac{s}{t}$ (where v = actual velocity) is true when s and t are very small, but the equation $V = \frac{s}{t}$ (where V = average velocity) is always true.

8. To find the space traversed in a given interval of time by a body moving with uniform velocity.

If v = the velocity, then by definition,

the space traversed in 1 unit of time = v

and since v is uniform

the space traversed in 2 units of time = $2v$

the space traversed in 3 units of time = $3v$

. . . . . .

and the space traversed in t units of time = tv

$\therefore$ if s = total space traversed, we have

$$s = vt.$$

or in words, distance = velocity × time.

For the convenience of the student we give the following:

TABLE OF METRIC UNITS OF LENGTH

1 metre	=	1,000 millimetres (mm.)
	=	100 centimetres (cm.)
	=	10 decimetres
10 metres	=	1 decametre
100 ,,	=	1 hectometre
1,000 ,,	=	1 kilometre (km.)
1 centimetre	=	0·39370428 inches
1 metre	=	39·37079 inches
1 kilometre	=	1093·6230 yards
	=	0·621375 miles

Exercise I.

1. A body moving with a uniform speed travels over 395 feet in 2½ seconds; what is its speed?

2. If a body is travelling with a uniform speed of 50 centimetres per second, how long will it take to travel 75 metres?

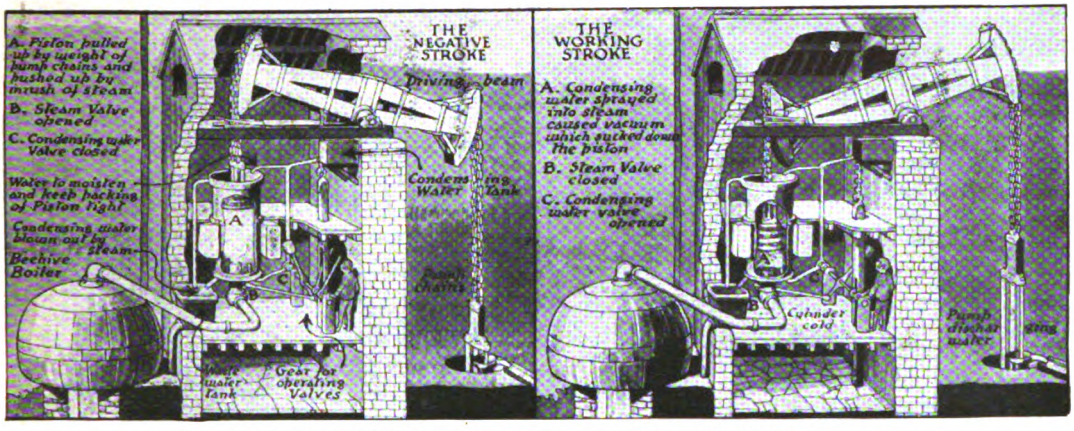
3. Which is the greater velocity, 80 feet per second or 66 miles per hour, and by how much does the one exceed the other?

M. A. L.

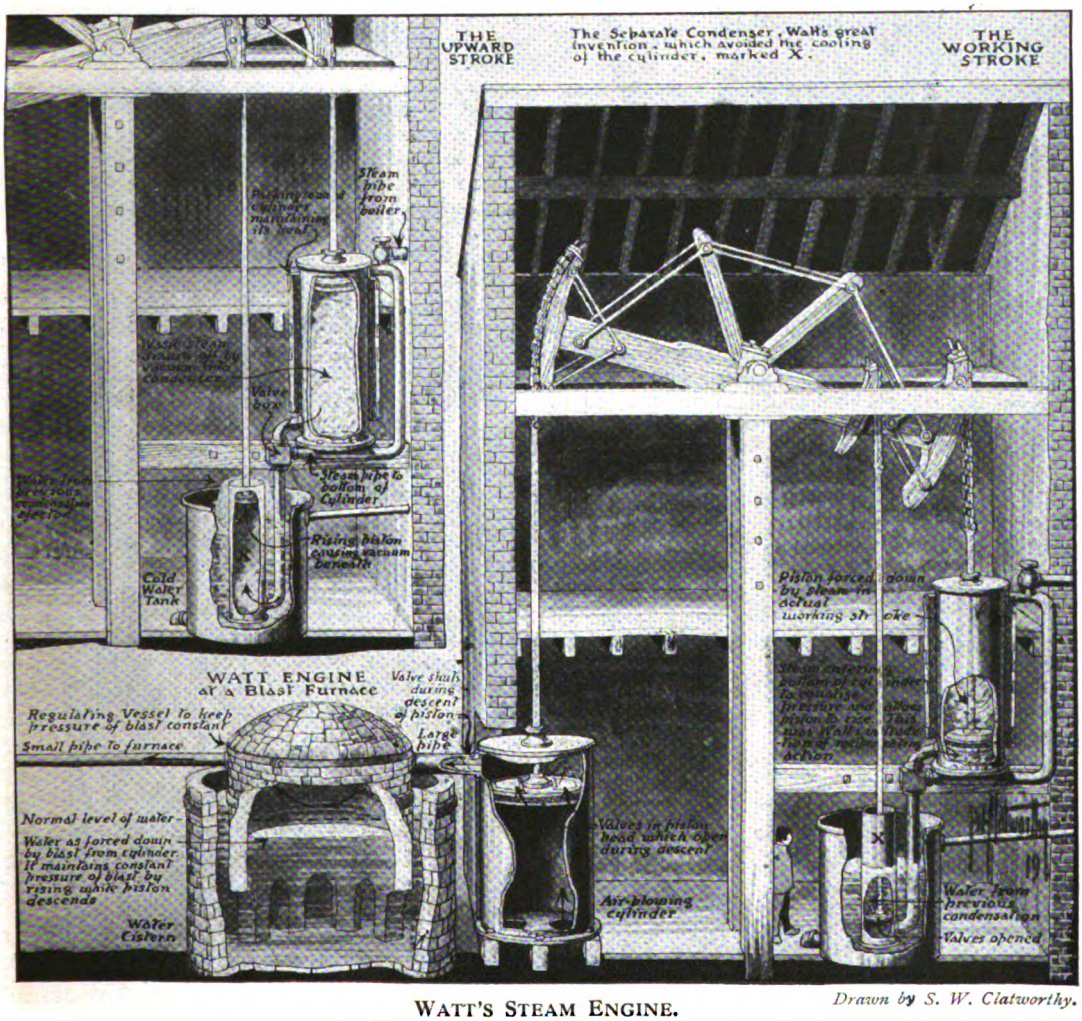
From the picture by Marcus Stone, R.A.

JAMES WATT (1736–1819) DISCOVERING THE CONDENSATION OF STEAM.

A discovery which enabled him to revolutionise eighteenth-century methods of manufacture and transport. The son of a small Greenock merchant, Watt went to London at the age of nineteen and secured employment in the manufacture of mathematical instruments. In 1763 he went to Glasgow where he began seriously to investigate the powers and properties of steam.



THE NEWCOMEN ENGINE, AS WATT FOUND IT.



WATT'S STEAM ENGINE.

Drawn by S. W. Clatworthy.

In 1763, when Watt went to Glasgow, he became much interested in the Newcomen "fire" engine (top panel). From this model, which depended for its power on a vacuum produced by steam condensation, he developed the true steam engine (lower panel). Some of Watt's engines worked for over a century.

Continued from page 369.

ART AND MUSIC:

Contributors:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

DRAWING.—XIV

WE must now turn our serious attention to such branches of anatomy as are absolutely essential to the artistic study of the human figure.

You should in the first place carefully learn the disposition of bones from the illustration of the skeleton. You should become perfectly familiar with the joints and the way in which they work—the hinge-like movement of the elbow and knee, the ball and socket of the hip. You should make a drawing of the skeleton and then cover it with the muscles copied from any work which gives them clearly and plainly illustrated.

Notice Fig. 75 and see how the muscles fit over the bones and the marvellous arrangement by which they work in unison. If you work on this scientific basis, you will learn more about the human body than you would in six months of study merely from casts and drawings, and you will learn it quickly, too.

You cannot hope for success in drawing the body without some knowledge of its workings. A tree is a tree, and a table a table. They do not change and alter, but so long as they remain a tree and a table they are fixed and immovable. Not so, however, the human form. An arm in repose is totally different from an arm bent to pull an oar; a leg in the act of running is another thing beside a leg standing. Such being the case, you must learn how a limb moves, how the muscles that control it make it conform to a certain shape at one moment and a totally different shape the next.

Of course, if you are content to make copies of drawings of the human figure, you need not learn any more than is necessary for the purposes of drawing still life; but your ambition will almost certainly, it is to be hoped, soar above this, and so some knowledge of anatomy becomes imperative.

Fig. 75 shows very clearly how the bones of the arm are covered with muscle. There is no need here to go through the entire human body, as the lesson once learned with regard to one or two particular limbs, the same will apply to other limbs. And you have, in the latter cases, only to apply that much needed quality of common sense to master the subject.

A very good way of learning the system from these figures is to draw the whole diagram first with a pencil. You should then carefully draw the lines of the bone again with black ink, and the muscles with red ink. You can then number the bones in your drawing and under the drawing make, with the numbers, a list of their names.

Take Fig. 75 as an instance: 1, is the *scapula* or shoulder-blade; 2, the *humerus* or bone of the upper arm; 3, the *olecranon* or point of the elbow; 4 and 5 are the *radius* and *ulna* respectively—these together forming the forearm. The *humerus* on the one hand and the *radius* and *ulna* on the other make a hinge-joint at the elbow. The *radius* is attached by a ligament outside the point of the elbow. At its other

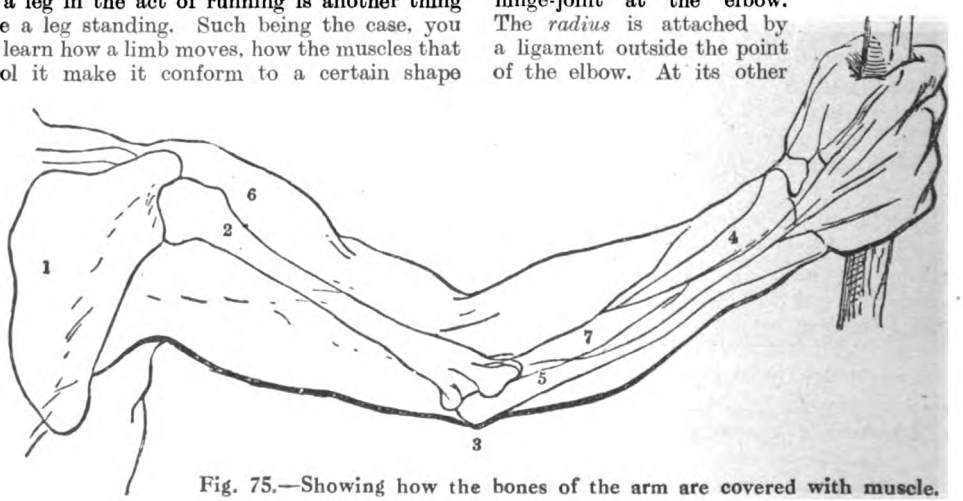


Fig. 75.—Showing how the bones of the arm are covered with muscle.

end—by the wrist, it is the base of support for the hand.

We must now deal with the muscles in the same manner. Number 6 is the *deltoid*, a large muscle which comes over the shoulder and goes down the arm. On one side of the body it rises from the collar-bone (*clavicula*), and on the other side from the *scapula*. The function of the *deltoid* muscle is to lift the arm from the side.

Number 7 is called the *extensor digitorum*, which arises from the outer protuberance of the *humerus*, and from the hinder part of the *radius* and the *ulna*. This divides at the wrist into three tendons which control the first three fingers. The exact action of this muscle is to pull back and extend the fingers, as may be gathered from its name.

You should work from excellent drawings and from plaster casts.

You should make a point of studying, and indeed drawing, the whole figure before you begin to specialise in the face and head—the most interesting part of the body.

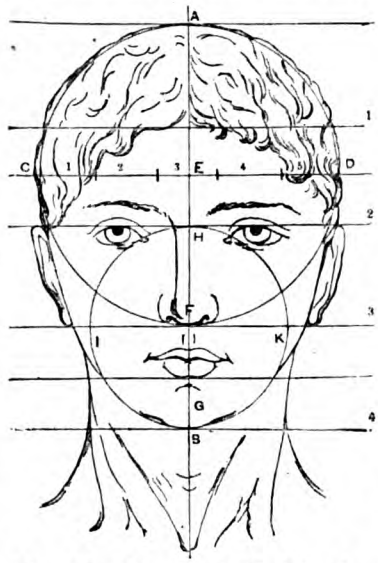


Fig. 76.—The Greek ideal head.

"To brutify a human countenance," writes Bell, in his *Essays on the Anatomy of Expression in Painting*, we have only to diminish the forehead, bring the eyes nearer, lengthen the jaws, shorten the nose and depress the mouth. If this be done, no expression of individual features will give elevation to the character, a breadth and squareness in the lower part of the face is quite consistent in a vulgar head with a certain representation of strength and manliness; but if the eyes be diminished and the space between them contracted, the expanse of the human countenance is lost, and there can remain no dignity of expression."

The most perfect form of head was generally reckoned by the Greeks and is still reckoned to-day to be the oval. In actual nature, however, this oval is not the general rule.

In order to get this ideal Greek head (to which you should on no account remain persistently faithful) the following directions may well be studied. Draw a line *A B* which shall be the full length of the head you intend to draw, that is to say, from the crown to the chin. Divide *A B* into four equal parts.

The first line will cut across the top of the forehead. The second will pass over the bridge of the nose and just over the pupil of the eye looking directly at you. The third line supports the nostrils—the base of the nose; the fourth line touches the point of the chin. The whole head in this way is of the length of four noses, whilst three quarters of the length represents the width of the head.

You now bisect the part containing the forehead at *E*, and with centre *E* and radius *E A*, you describe the circle *A D F C*. Then draw *C D* through *E* at right angles to *A B*. In the section containing the nose (which is the third division) you make *F* your centre and *F B* your radius and draw the circle *B H I K*. Then you draw two curved lines joining the two circles in such a way that the ears are contained between the lines 2 and 3. These two circles with the joining lines now form an oval. Now divide the line *C D* into five equal parts.

In divisions 2 and 4 of this line you will find the eyes. Bisect *F B* and draw a line through it at right angles at the point *G*. *G B* will represent the length from the underlip to the chin point. The distance from *G* to the opening of the lips is one third of the line from *F* to *G*. The width of the upper should be considerably less than that of the lower lip. Notice that the ears and nose are of the same length.

If you follow out these proportions accurately, you will always be able to draw a good head; though natural heads may and often do deviate very materially from this Greek ideal.

Fig. 77.

Fig. 78.

Fig. 79.

The greatest difference to be noticed between various heads is the facial angle; which is the inclination of the face from the base line of the skull, omitting the lower jaw. The profile of the negro in Fig. 77 has the angle *A B C* very much more acute than that of the European Fig. 78.

The angle in the case of the negro is about 50°, in the European it is about 70°. The Greek ideal is expressed by 90° in Fig. 79. J. G. B. L.

DECORATIVE ART.—I

THE art student will almost insensibly turn his attention after a time to the question of decoration, as applied to houses. For indeed no artistically minded person can live in a house which is not in some way beautiful.

Decoration is sometimes useless to beauty. By this is meant any decoration which is not inherent in building. The most beautiful houses are invariably those which are properly treated by the architect and builder. The desired factors are a perfectly proportioned room and good furniture and decoration.

The most beautiful furniture, the most costly hangings, the finest panellings or paper will be all wasted in a room of mean proportions. That stricture does not necessarily apply to small rooms, but to badly designed ones.

Simplicity

There is indeed almost too great an outcry for simplicity within the house to-day. Decoration, by which I mean here—necessary decoration, including furniture, curtains, carpets and so forth, can be of two kinds; simply good and elaborately good. Only, and this is the supremely important point, if your decoration is to be elaborate, it is infinitely more essential that it should be of the highest order than if it is simple. What is really simple can hardly help but be effective, for there is no pretence about it. What is elaborate is always open to the charge of pretentiousness if it is not extremely well done.

The two great points which you must ever strive to combine are usefulness and beauty. But indeed useless things, particularly in the way of furniture, are scarcely ever beautiful. And that is one reason why a "best" room in certain sorts of houses, which is hardly ever used except when "company" is present, is rarely an endurable room to be in. It is not lived in. It does not convey the atmosphere of homeliness. Everything in it is for display, from the antimacassars on the backs of chairs to the large vases of vivid milky green and pink.

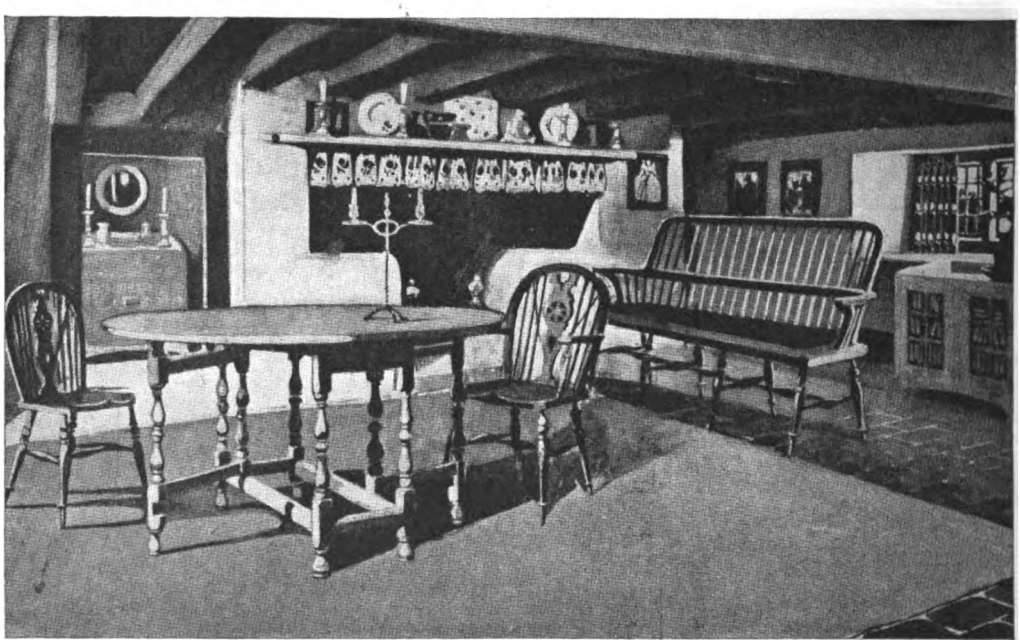
China and Pictures

China should always be avoided, unless by its design, colour, material or workmanship it is worthy of the space it fills.

The same applies to pictures. A room without pictures is impossible? Not at all. But you are likely to grow tired of bare walls, so let your pictures be good ones, simply framed.

The simple framing is important, because a frame that is not simple must be exceedingly good and rather costly, and even then it tends to draw attention away from the picture. Have few pictures, and select those from which there is always something to learn.

J. G. B. L.



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A ROOM WHICH COMBINES SIMPLICITY WITH BEAUTY AND UTILITY.

Continued from page 376.

BUSINESS AND COMMERCE:

***Contributors*:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).**

COMMERCIAL TRAINING.—XXI

GENERALLY speaking, we may divide our trade into two broad classes—the wholesale and the retail. In this lesson we purpose dealing with the former class, though it should not be forgotten that there are many business concerns so divided that the one house is in both wholesale *and* retail trade. In such instances, however, the student of business training may conveniently regard such a business as two separate undertakings.

The wholesale trader or firm may be the actual producers, or may buy goods from the producers ; in some cases they may be importers of a particular class of goods. Wholesalers dispose of their goods to retailers and the retailers sell them to the actual consumers.

The agent forming the connecting link between the wholesaler and retailer is often the commercial traveller.

Wholesale Trade

We start then with the actual goods that have been imported or produced. The producer may sell them himself or he may dispose of his goods to a wholesaler. The wholesaler will almost certainly need a warehouse for the storage of goods ; he will require a good deal of capital in order to buy advantageously ; he will keep a staff of clerks, and divide his office into sections—the buying and the sales departments.

Further, he will engage a staff of commercial travellers and assign to each a district in which to operate. The wholesaler's profits will be derived from the difference between his buying and selling price, less the cost of his organisation.

The routine of the commercial traveller is broadly upon these lines. In the first place, he is given a definite area to work, and will usually arrange his journeys in such a way that they recur at regular intervals.

In most trades the traveller will carry samples of the wares he offers. In some cases where these samples represent a considerable bulk, the traveller will engage a stock room at the commercial hotel where he stays, and will arrange his samples to the best advantage for buyers to inspect. In other cases, such as with woodwork, builders' requisites, and so on, small models of the goods are sometimes carried in lieu of samples.

And it must be remembered that the commercial traveller is in every sense an ambassador of trade. It is his purpose mainly to sell. But beyond selling he has to feel the pulse of his trade, to watch his competitors, to ascertain the trend of public requirements, and to make detailed reports and suggestions to his principals as to the type of goods that are most likely to sell readily. The traveller must understand every detail of his own trade ; and it is for this reason that so many commercials learn their business in the offices and warehouses.

Commercial travellers receive no special allowances from the railway companies, but they are specially catered for at commercial hotels throughout the country, where, in addition to the stock rooms, writing apartments are provided.

Commercial Travellers

Orders as they are received are entered in an order book ; and at the close of the day, at his hotel, the traveller writes to his employers enclosing the list of orders he has obtained.

In some cases he will make a detailed report of his day's work, give suggestions, notes as to a customer's financial stability, particulars of how goods are to be forwarded, and similar matters. The question of financial stability is most important, for

upon it are hinged matters of cash or credit. Further, bad debts count as black marks against a traveller: he should, therefore, not neglect this point.

Thus, working town by town, the commercial traveller completes his circuit, gaining a great deal of most vital information in addition to his orders, and on his return to the office will probably be received by one of the principals, to whom he will summarise the results of his mission.

And now, to return to the wholesale warehouse, we may well imagine the receipt of the orders one morning from the various commercial travellers. The slips are closely scanned from the point of view of the financial status of the customers; for it will be obvious that, without express mention from the traveller, a buyer known to be in a shaky condition would not be trusted with an order larger than usual.

The orders having been approved by the ledger keeper or other responsible clerk, they are then passed to the dispatch clerks, who deal with them; and these clerks must have a wide knowledge of railway rates, railway routes, shipping matters, and canal charges, so that the goods may be dispatched quickly and cheaply.

Insurance of Goods

Another matter with which the wholesale clerk should make himself acquainted is the insurance of articles dispatched by rail. For the purpose of insurance valuable and fragile articles are divided into classes, most companies having four classes. Silks, furs, clocks, and plated articles, to quote examples, fall into one class; jewellery, lace, trinkets, and deeds form a second; china and glass a third; pictures a fourth, and so on.

The rates of insurance are then quoted according to class and to the nature of the journey, whether it be all by rail or partly by sea, as is the case with goods to be dispatched to Ireland.

In every town, of course, there are goods agents from whom rates for the carriage of goods to all parts may be obtained; and the clerk should remember that for the carriage of goods by passenger train fixed charges are made by all the companies, according to distance and weight. In most cases when goods are dispatched by goods train a consignment note has to be supplied on forms provided by the railway company, this note giving details of the weight of the package, destination, conditions under which it is carried, and so on.

A. B.

CHOOSING A CAREER.—XXIII

Art and Music.—An artist must be born with artistic talents; but it stands to reason that there must be many men and women with an immense amount of skill who have not been able to turn that latent ability to use.

In every town of importance in the country there are technical institutes of which a school of art forms a part, and such schools are ideal for the young student.

By the time he has spent several terms at an art class he should be able to decide, with the advice of his masters, whether there lies before him a profitable and congenial career as an artist.

Art as a profession may be divided into the following branches:

1. *Painting*, pure and simple, for the sale of one's pictures. It goes without saying that the painter must be well above the level of mediocrity, and that he must have some special bent all his own—the ability for rendering landscape, seascape, shipping or some other subject. Only a few painters are able to make a generous livelihood out of such work.

2. *Portraiture;* that is, the painting of portraits. Many artists with a wide circle of patrons earn handsome remuneration as portraitists.

3. *Black and white work* for the press is one of the most profitable and consistent methods of founding a career as an artist and opens a very wide field. Black and white work may be subdivided into two sections, line drawing and wash drawing. The former is done with pen and ink; the latter with a brush.

To become a press artist one must again specialise. Specimens of one's work should be submitted to the various art editors of periodicals and magazines.

4. *Colour work for reproduction* offers similar opportunities to black and white, and there are many publications that use coloured covers and occasionally coloured pages, and such papers or magazines should be studied and likely efforts be submitted to them.

At the same time it should be pointed out that the market for coloured work is by no means limited to editors. Book publishers will frequently take a smart coloured design for a cover, and there are printers to whom coloured designs may be submitted for use as advertising showcards, calendars, tin-box covers, Christmas cards and a variety of other uses.

5. *Posters.* In some measure this is only a development of Sections 3 and 4. There is a great opening for artists who can do theatrical posters effectively. To obtain this class of work artists should submit specimens to theatrical poster firms, such as Messrs. David Allen & Sons, of London, Harrow and Belfast.

6. *Lithographic artists.* Lithography, which consists of drawing upon stone, is an ancient art; and the artist is called upon not to provide original compositions but to copy the work of others. Many art students go in for lithography as a step in their career.

7. *Fashions.* Here there is an important opening for clever men and women. Designing is as important as knowledge of drawing; but in addition to designer-artists there are artists who copy and amplify designs. Many large costumiers, milliners and ladies' outfitters employ designers and artists, and there are also openings in the men's tailoring.

8. *Scene-painting.* This work, quite an art in itself, is usually learned by a system of apprenticeship to scene-painters.

9. *Sculptors and modellers*, except they are in the first flight, are not in great demand; but wood carvers can be more certain of a regular living, and this latter profession is well worthy of the student's attention.

10. *Art masters* at general and art schools must be all-round artists, qualified to teach, and trained at high-class academies or abroad. Except in a few cases, art masters are not well paid.

And even with this formidable list we have not exhausted the ramifications of art as a profession. There are art editors employed by firms of publishers; artists who specialise in the interior decoration of yachts and ships; others who paint animals; designers of furniture, book-plates, medallions; heraldic artists; etchers; fine art engravers; pastel workers and others. There are no standards of salary or income, but an artist should, for his own sake, endeavour to acquire a knowledge of business methods.

Music as a Profession is naturally dependent upon the accomplishments of the individual, and it must be remembered that there are innumerable men and women of average attainments, so that the person desiring to make music a career must first determine that he is well above the level of mediocrity.

Having obtained the hope and promise of a man qualified to offer an opinion, there is a long period of tuition and study to be faced, a period that in the case of a vocalist at least may be relieved by a few minor engagements.

As for the ultimate prospects of a vocalist, it should be borne in mind that for every successful star whose name is on everyone's lips there are a hundred failures; and in the rank and file of the concert platform or of opera an income of £300 a year is considered high, so that there are many other professions with far greater financial inducements.

Instrumental music naturally offers many more attractions than does mere vocalism, for it presents so many more phases. There is church music to be considered, music masterships, choir masterships and many kindred appointments.

Starting with those aspirants who can take the very highest form of training, there are many university degrees to be won by ambitious students. With full residence at the university a candidate may become a Bachelor of Music or a Doctor at either Oxford or Cambridge, and many of the modern universities grant degrees without residence to candidates who can pass the tests.

The Royal College of Organists in London also grants musical diplomas, and so do many of the larger training colleges, such as the Royal Academy of Music, London, the Guildhall School of Music, London, and several provincial institutions; whilst in some circumstances there are scholarships to be won.

Organists at places of worship are seldom paid more than £100 a year, and many of the cathedrals can only afford their organists about twice that sum.

It is in the *teaching of music* that there are the most frequent openings. At many of our large schools the organist is also music master; and at the schools of music and the universities there are valuable musical professorships. Moreover, a church organist is in no way debarred from building up a private school in his own home, frequently most successful and remunerative.

Military bands are recruited almost entirely from the Military School of Music at Kneller Hall, Twickenham, Middlesex; but in some circumstances accomplished instrumentalists may enlist, their Army pay being supplemented by the earnings of the band at various private engagements. The *orchestras at theatres* and music halls also offer employment to trained musicians, but the salaries are not high, £3 or £4 a week being a fair average. A. C. M.

BOOK-KEEPING.—XVII

In the last lesson (on page 376) something was said regarding contracts. This we will now amplify.

On the acceptance of the contracts it would be advisable for you to adopt some plan whereby a definite number is allotted to each contract. One way in which this may be done is by the employment of a **Works Order Book.** This book contains perforated and fixed leaves, so that two copies may be made of a general statement or summary of each contract.

An account will be opened in your Ledger for each contract, and also for materials. The Contract Account will be debited with all material supplied and costs incurred, and credited with Cash received on account.

The Materials Account will be debited with Stock on hand at the commencement, and credited with materials sent out to the contracts, and with Stock at the finish. The balance will represent profit or loss on materials.

Let us suppose that the following materials have been sent to the site; these will be journalised thus :—

Contract No. 150	Dr. £100 – –	
,, No. 200	,, 170 – –	
,, No. 300	,, 200 – –	
,, No. 350	,, 190 – –	
To Materials		£660 – –
	£660 – –	£660 – –

Labour is always a very important and considerable item in the carrying out of contracts, and in the cases we have cited it is found that certain payments are made for wages.

These payments form part of the cost of the contracts, and will be debited to the Contract Accounts after having been entered in the Cash Book as follows :—

Dr. CASH BOOK *Cr.*

Receipts			Payments	£	s.	d.
			By Wages Contract 150	50	–	–
			,, ,, 200	80	–	–
			,, ,, 300	75	–	–
			,, ,, 350	83	–	–

In the course of the contract you may apply to the supervising architect for some payment on account of work done. Such requests are often referred to as **Applications for Draws.** If the architect agrees that your application is justified, he will issue a certificate, on presentation of which a cheque will be paid to you for the amount specified.

Theoretically speaking, these instalments should be placed to the credit of the Contract Accounts, though in practice they will most likely be placed to the credit of the Personal Accounts.

Suppose that you have received a first instalment on each Contract, the Cash Book entries for these amounts will be as shown below.

As these Contracts progress, the procedure we have outlined will be continued. Materials will be supplied from time to time to each job, wages will be paid weekly, and instalments will be received on account.

Dr. CASH BOOK *Cr.*

Receipts		£	s.	d.	Payments
To Contract No. 150		2,000	–	–	
,, No. 200		1,000	–	–	
,, No. 300		2,000	–	–	
,, No. 350		900	–	–	

At this point it may be well for us to attempt to distinguish between plant and materials, as they are terms which are often confused by students. Broadly speaking, materials are those things which are put into the actual construction of a building, whereas plant consists of things which are used and are brought away again when the work is finished.

All these items will be entered in the subsidiary books, and in the manner already shown.

In the next lesson we will deal with further points on Contracts, and give an explanation as to how these Contract Accounts are completed.

F. H.

JOHN BULL—FARMER.

Showing how he apportions his Great Britain estates, which comprise some 32,000,000 acres of cultivated land. *(See pages 494–496.)*

Continued from page 379.

ENGLISH LANGUAGE AND LITERATURE:

***Contributors*:**—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

PROSE OF THE LATER EIGHTEENTH CENTURY

In the third quarter of the eighteenth century the writing of general history in English may be said to have begun. Works like Clarendon's *History*, and Bishop Burnet's *History of My Own Time* had been of the nature of memoirs, with the advantages and disadvantages of picturing contemporaneous controversies. The older continuous histories were bare chronicles or records. Now, however, following examples already set in French literature, attempts were made to survey wide periods in a scientific spirit, with an approach to impartiality, and in a style that combined clearness with dignity. From a number of would-be historians three stand forth pre-eminent: David Hume, William Robertson, and Edward Gibbon. Hume's first historical volumes appeared in 1754; Robertson's in 1759; Gibbon's in 1776.

David Hume—

David Hume was born in Edinburgh, April, 1711. As a youth he attended the University there, making philosophy his special study, and literary fame his dominating ambition. After finding himself out of place in preparing for the law, and in business, which he tried because he thought its activity would benefit his health, he lived in France from his twenty-fourth to his twenty-seventh year on very slender means, and there wrote his *Treatise on Human Nature*, published in three volumes in 1739 and 1740. This book, which contained Hume's philosophy in its freshest form, fell still-born from the press. Later it was recast, in part, in a different form, and through it Hume's became the most stimulating philosophic mind in Europe. *Essays, Moral and Philosophical* appeared in 1741 and 1742, and Hume began to be known as an original thinker and polished writer.

In 1747 Hume became secretary to General St. Clair, and Judge Advocate, in an expedition against the French coast, and next year accompanied the general as his secretary on a diplomatic mission which visited France, Holland, Germany, Austria, and Italy. These services gave him an easier financial position. In 1751 he published an *Inquiry into the Principles of Morals*, and next year his *Political Discourses*, which were well received abroad, and introduced the principles of Free Trade, afterwards developed by Adam Smith.

—as a Historian

Hume had now become well known as an independent thinker, but was widely suspected for his sceptical tone of mind. He failed to secure more than one professorship, but was made librarian of the Advocate's Library, the largest in Edinburgh, at a salary of £40 a year. The library included an extensive historical collection of books, and suggested to the librarian the writing of a history of England. The issue of the volumes was peculiar. The first volume (1754) contained the reigns of James I. and Charles I.; the second (1756) included the period between the execution of Charles and the Revolution of 1688. Two more volumes (1759) went back to the Tudor period; and in 1761 a final issue of two volumes filled in the national story between the coming of Julius Cæsar and the coming of Henry VII.

Though Hume grumbled at the inadequate sale of his history, it became the standard national record for more than one generation, and when he went to France in 1763, as Secretary to the British Embassy, he found himself a literary lion in the most brilliant circles of French society. A generous

attempt to give Rousseau a comfortable asylum in England was frustrated by the Frenchman's insane suspicions.

On returning from France Hume was made Under-Secretary of the Home Department, and held the appointment for a year. In 1769 he returned to Edinburgh, where he lived till his death in August, 1776, a popular figure in society, with enough savings to feel himself "very opulent," and a full measure of the literary fame he had sought. He was as distinctly the great literary personage of the northern capital as Dr. Johnson was the presiding genius of English authorship in London.

David Hume's most substantial distinction was as a fearless logical thinker and philosopher. As a historian he was superficial and prejudiced. He was willing to accept statements from books without testing their accuracy by research, and, in consequence, his history was full of errors, sometimes serious. His revisions, in later editions, only deepened its manifest prejudices. Now the work carries no authority. But on the other hand it was the first general history covering social as well as dynastic and political changes. It viewed human life in the gross as a developing sequence. And, above all, it made the reading of history a delight to the average educated man, by its easy movement, grace of style, and dramatic groupings.

William Robertson

William Robertson, son of a Presbyterian minister, was born in September, 1721, educated at Edinburgh, became the most popular preacher of his day in Scotland, and, at the age of forty-one, Principal of Edinburgh University. Next year he was also appointed Historiographer Royal for Scotland. For sixteen years, from 1763, he was elected Moderator of the General Assembly.

Stimulated by the example of his friend, Hume, he wrote a *History of Scotland*, covering specially the reigns of Queen Mary and her son James VI., but including a preliminary sketch of the national history. This work, published in 1759, at once became popular, especially in England.

Ten years later his *History of Charles V.*, with a lengthy introduction on the Middle Ages leading up towards the Emperor's reign, gave Robertson a European reputation. This was the first book in English which dealt with European history on a wide scale. Nine years later a *History of America* followed.

For his *Charles V.* Robertson received £4,500, the highest price paid up to that time for a work on history, and he was regarded popularly as the leading British historian, but he has been superseded for three reasons. Like Hume, he did not sufficiently sift his materials, which were themselves inadequate for his purposes; his historical generalisations, though sometimes founded on shrewd insight, were often unsound; and his style, aiming always at dignity, became formal and pompous.

He was an estimable and genial man, and Scot though he was, Dr. Johnson admitted that he loved him, even while he used his writing as an example of the style that would be improved by having all its particularly fine passages struck out.

Edward Gibbon

Edward Gibbon, who, with a modesty that sounds affected to-day, declared that he did not presume to take a place as a historian with Hume and Robertson, succeeded, in his monumental *Decline and Fall of the Roman Empire*, in writing the history of a vast and obscure period, achieving by an extensive research, an accuracy in detail, a grasp of vast racial movements, a grouping of the most pregnant interests, and a grandeur of style that have left his work an invaluable heritage for all succeeding generations.

Gibbon was born in London, April 27th, 1737, the son of a Tory Member of Parliament, supposed to be of ample means, who retired into a Hampshire village when his first wife died. The son, then an ailing boy ten years of age, was cared for in London by an aunt. His education was desultory, but his reading omnivorous. When he was fifteen, his health having improved, he was sent to Oxford, where he remained without profit for fourteen months, an experience that left him with a permanent contempt for university education. He escaped from Oxford by joining the Roman Catholic Church, whereupon his father sent him, when just turned sixteen, to a Protestant minister at Lausanne to be re-converted, a consummation reached eighteen months afterwards.

In his twenty-second year he returned with a partly written *Essay on the Study of Literature* in his pocket, and a fine command of Latin and French, the latter being the language in which the *Study* was written. While in Switzerland he had fallen mildly in love with the daughter of a Swiss pastor, but his father disapproving of the union he broke off the match, and the lady afterwards married M. Necker, the famous French financial-statesman, and became the mother

of the brilliant society leader and writer Madame de Staël, and Gibbon, who retained Madame Necker's friendship, died a bachelor.

Gibbon now made his home in Hampshire, finished his French essay, and became a captain of militia—an experience which he referred to later as "not useless to the historian of the Roman Empire." The *Essay*, published in 1761, had some success abroad, as he found when visiting France. It was while travelling in Italy, on October 15th, 1764, as he records with historical exactness, that "musing amid the ruins of the Capitol," the idea of writing the story of the *Decline and Fall of the Roman Empire* came into his mind.

His father died in 1770, leaving him an encumbered estate and a mother-in-law to care for. As soon as he could manage his affairs he moved to London.

In 1774 he became a member of Dr. Johnson's celebrated club; but Boswell, who cordially detested him, tells us little about him. In the same year he was elected

From a print by James Hall, after the portrait by Sir Joshua Reynolds.

EDWARD GIBBON (1737–94),

the great historian whose *Decline and Fall of the Roman Empire* still stands as the standard for historical writing.

Professor of Ancient History at the Royal Academy, and a Member of Parliament, his constituency being first Liskeard, and, later, Lymington. Though Gibbon never spoke in the House, he was rewarded eventually for faithful voting and some official defensive writing by being made one of the Lords Commissioners of Trade and Plantations.

In 1776 the first volume of the great History was published, and immediately became popular in the midst of clamorous disapproval, for the attitude of the historian was regarded as hostile towards early Christianity in a subtle way. The second and third volumes were issued five years later. Shortly before the fourth volume was finished Gibbon settled in Lausanne with his six thousand books, and there completed the six volumes

From the portrait by Sir Joshua Reynolds, in the National Gallery. Photo: Emery Walker.

EDMUND BURKE (1729–97),

whose printed speeches are far in advance of anything which had been contributed before by politics to literature.

by the night of June 27th, 1787. The work had closely occupied his thoughts for seventeen, and his pen for fifteen, years.

The life of the historian extended to six and a half more years. The publication of his last three volumes coincided, in 1788, with his fifty-first birthday. Afterwards Gibbon wrote only the sketches of his life, which were sub-edited and dovetailed by his friend Lord Sheffield into continuous autobiographic *Memoirs*. His last years were spent chiefly at Lausanne, but he returned to England in May, 1793, and died on January 16th, 1794, in London.

In person Gibbon was not impressive. The Swiss pastor with whom he lived after he left Oxford described him in his youth as "a thin little figure with a large head, disputing and arguing with the greatest ability." His excessive corpulence in later life, when he took no exercise, was the greater disfigurement, as he was under five feet in height. George Colman said "his mouth, mellifluous as Plato's, was a round hole

From the picture by E. M. Ward, R.A., in the National Gallery.

DR. JOHNSON IN THE ANTE-ROOM OF LORD CHESTERFIELD,

the great patron of eighteenth-century art and letters. Patronage, however, was not at all to the liking of the proud doctor. "Seven years, my lord, have now passed," he subsequently wrote to Lord Chesterfield, "since I . . . was repulsed from your door. . . . Such treatment I did not expect for I have never had a patron before."

nearly in the centre of his visage." His style in conversation seems to have been a reduced replica of his writing. As a friend Gibbon was constant and inspired constancy. His geniality, good temper, and placidity closely resembled the qualities of his contemporary, David Hume. Really, however, Gibbon only lives in his history and memoirs.

He selected, after long thought, as the subject of his life's writing, the greatest drama in human history—the change in the chief nations from paganism to Christianity. This change, extending over more than a thousand years, he studied till he knew all that could be known about it in the books then available.

His record, divided into two great chapters, each absorbing three volumes, embraced the fall of Rome and the Western Empire, and the fall of Constantinople and the Eastern Empire. In each case he pictures, with panoramic breadth, the gathering of the storm clouds destined to descend in seemingly irretrievable destruction. When filling this great historical canvas he had no guidance from predecessors in the art. His was the first history on such a scale. And, by universal admission, it remains essentially intact, unassailable, indispensable.

A Standard for Historical Writing

It is true that later researches have revealed information unknown in Gibbon's day, information that has altered the perspective somewhat here and there, particularly in relation to the part played by the Slavonic peoples. It is true that the tone of the historian's mind leaves much to be desired, notably his insensibility to great spiritual influences, which moulded men more fatefully than he realised. It is true that he gave way to a natural tendency to attack what he regarded as superstition with covert sneers that hinted a disapproval which he refrained from expressing openly. But, in the main, his work stands, finally done, once for all, and it set a standard for historical writing that has not been, and is not likely to be, superseded.

Samuel Johnson, the most prominent literary figure of the last half of the eighteenth century, is known to the world chiefly by his personality and talk, and not by his writings. He was seventy years old when he published his best book—*The Lives of the Poets*—but he had then been known for a generation as a very distinguished man. That distinction was preserved for all time by the publication of his *Life*, by James Boswell, six and a half years after his death. Johnson remains a great English "character."

He was born, an ailing child, September 8th, 1709, the son of a Lichfield bookseller. A voracious reader rather than an exact scholar, he studied, between the ages of nineteen and twenty-two, at Pembroke College, Oxford, leaving, owing to the death of his father, without taking a degree. Till he was eight and twenty he was an unsuccessful schoolmaster in the country, then he went to London with a partly written play in his pocket.

Samuel Johnson

During the next ten years he was an impecunious poet, and what would now be called a journalist. From his thirty-eighth to his forty-fifth year he was busy compiling his great Dictionary, with journalism and the writing of his periodical *Rambler* essays as a bread-and-cheese variation. The publication of his *Dictionary* in 1755 established him in position, but he was still proudly poor.

At one time he sought, but apparently failed to receive, the patronage of Lord Chesterfield. "Seven years, my lord, have now passed," he subsequently wrote to Lord Chesterfield, "since I . . . was repulsed from your door, during which time I have been pushing on my work through difficulties, of which it is useless to complain . . . . without one act of assistance, one word of encouragement, or one smile of favours. Such treatment I did not expect for I have never had a patron before."

In his forty-eighth year he began the periodical *Idler*, and next year wrote his moral and philosophical tale *Rasselas*, to pay the cost of his mother's funeral. When he was fifty-two he received a pension of £300 a year, and thenceforward lived a life of social leisure, with periods of intermittent industry.

It cannot be said that up to this time Johnson's influence on English prose had been advantageous. He introduced a ponderous Latinity, a formal balance of heavily loaded sentences, which caught the ear and made a fashion, but irretrievably spoiled writers of his day who began with vivacity and grace. The most fatal instance was his brilliant young friend Fanny Burney, who, in her *Diary*, and to a less extent in her first story, achieved a style which reminds the reader of the bright course of a white-winged yacht, and who ended with the waterlogged motion of a Dutch merchantman.

Had Johnson ceased writing when he accepted his pension, he would have been

forgiven his faults with difficulty; but late in life he made some amends by writing in much less cumbrous fashion his *Lives of the Poets*, mixtures of biography and criticism. His judgment of poetry was marred by an acceptance of tyrannous rules, and a strange inability to enjoy some of the loveliest verse in the language.

The genuine Johnson cannot be seen adequately in his writings. We must live with him in Boswell's amazing biography. There, though the book is packed with prejudice, partly humorous prejudice in Johnson, and malice in Boswell, we can see the literary circle of the age as no other literary circle has ever been pictured, unless it be the circle in which Charles Lamb moved fifty years later. In the freedom of that circle we learn to love the brave old man for his manly honesty, his mental vigour, his essential goodness, and for his abounding faults.

Having lived for thirty years as the last of the coffee-house kings—in direct line of succession from Ben Jonson and John Dryden—Johnson died December 13th, 1784. Buried in Westminster Abbey, he has a monument in St. Paul's, another at Lichfield, and a third at the Fleet Street end of St. Clement Danes, where he worshipped.

James Boswell

James Boswell, son of a Scottish judge, was born in 1740, and died in his fifty-fifth year, after a life of foolish failures, redeemed only by the fact that he wrote in *The Life of Samuel Johnson, LL.D.* (published 1791), the best biography in the English tongue. How such a man could write such a book will be a source of unending wonderment. Bigoted to the core, vain, flighty, thriftless, and tipsy, with a strain of malicious jealousy in his nature, Boswell seemed to turn all his powers into the channel of hero-worship. To him Sam Johnson was a demi-god. In his hero's presence observation and memory were preternaturally sharpened, and the gift of staging his beloved master developed till it approached dramatic genius. He could not bear to see anyone in the neighbourhood of the throne, even as a worshipper. Such men as Goldsmith and Gibbon he hated, because he knew they were destined to fame. All he had to say of David Hume and Adam Smith, who had been his tutor, was that he should like to see Johnson jowl their heads together. Boswell's was the first complete biography, and in it the art of picturing a human life and character was carried most nearly to perfection.

Adam Smith, who belonged to the literary circles of both London and Edinburgh, was born in Kirkcaldy in 1723, educated at both Edinburgh and Oxford Universities, and became Professor at Glasgow, first of Logic, and then of Moral Philosophy. There he wrote his *Theory of Moral Sentiments*, which gave to sympathy an all-important place in psychology.

Resigning his professorship he travelled on the Continent as a tutor. On his return he spent ten years at Kirkcaldy (1766 to 1776) writing his *Inquiry into the Nature and Causes of the Wealth of Nations*, a book which eventually profoundly modified the economic policy of Great Britain. In it he argued that wealth is derived primarily from the land and labour, and that its production is most naturally assisted by free trade. The study of political economy has ever since been based on Adam Smith's line of thought, with, of course, certain modifications. He died in 1790.

Edmund Burke

As Adam Smith founded the science of economics, so Edmund Burke, another member of Dr. Johnson's Literary Club, may be said to have founded the more miscellaneous literature of politics. Burke was born in Dublin, 1729, the son of a lawyer. He was educated at Trinity College, and designed for the law, but on coming to London to study for the bar gravitated towards authorship and journalism. In the latter capacity he wrote for thirty years the survey of the world's doings in *The Annual Register*. His first books were philosophical, a satirical *Vindication of Natural Society* in the style of Bolingbroke, and an inquiry into *The Origins of Our Ideas of the Sublime and Beautiful*. The latter work was exceedingly popular, and it is still reprinted, though it has little value as a study, either of æsthetics or psychology.

In 1761 Burke returned to Ireland as private secretary to the Chief Secretary; and four years later was appointed private secretary to the Prime Minister, the Marquis of Rockingham, and became a Member of Parliament. Midway through a parliamentary career of nearly thirty years he once held office for about a year as Paymaster of the Forces, but almost invariably was in opposition.

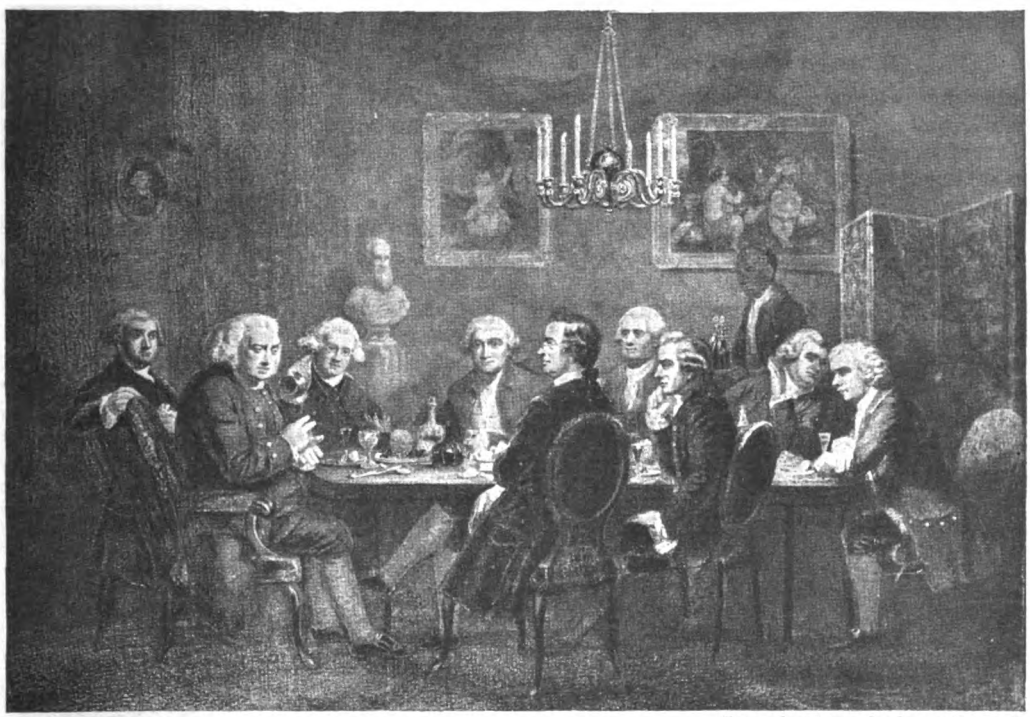
His chief activities in Parliament and the Press centred round three subjects: the war with the American Colonies, the impeachment of Warren Hastings, and resistance to the French Revolution. On these topics he spoke in the House with what his fellow

members often regarded as wearisome eloquence. Printed, his speeches are fine political literature.

As speeches Burke's utterances lose something by being too literary, as literature they lose something by being too oratorical; but they contain, among grievous misreadings of history, studies in political principles that were far in advance of anything contributed before by politics to literature. His discussion of the stupid tyranny that alienated the American Colonies was masterly; his ideas on the duty of Great Britain to India have been generally accepted; but he failed to grasp the underlying significance of the French Revolution. His most characteristic speeches and writings are *Thoughts on the Present Discontent* (1770); *American Taxation* (1774); *Conciliation with America* (1775); *Reflections on the French Revolution* (1790).

Burke died in 1797. How he had lived was always a mystery, for he was deeply in debt, even after he was heavily pensioned in his latest years.

Passing from the dominant figures of later eighteenth century prose we must mention briefly certain writers who either began or developed forms of literature which in years to come assumed greater importance. To the amiable Sir Joshua Reynolds, perhaps the greatest of English portrait painters, the founder of the Literary Club, and the first President of the Royal Academy, we owe, for instance, the first English book on art that continues to be read with pleasure and profit to the present day—his *Discourses* on painting delivered to the Academy students.



From the picture by James E. Doyle.

A LITERARY PARTY AT SIR JOSHUA REYNOLDS.

To the left of the picture Dr. Johnson can be seen talking to Edmund Burke; Boswell is seated on the doctor's left, with Sir Joshua Reynolds next to him; then David Garrick and Pascal Paoli; then Warton, who is seen whispering to Oliver Goldsmith; and Charles Burney.

The Rev. Gilbert White, curate of Selborne, and holder of several college livings, a boy-pupil of Dr. Thomas Warton (vicar of Basingstoke, and sometime Professor of Poetry at Oxford), having settled in his later years at his native village, wrote, in letters to friends who had a smattering of science, descriptions of *The Natural History and Antiquities of Selborne*. These letters, published as a book in 1789, are the germ from which much delightful modern writing on out-door life, birds, plant-life, and weather-lore, has sprung, none of it, however, excelling the parent book in closeness of observation.

Dr. Warton had, as fellow pupils with young Gilbert White, his own two sons, Joseph and Thomas Warton, both of whom became members of the Johnsonian Literary Club, and helped in some degree to mould our growing literature.

Other literary work that came from the Club Circle and has retained its full vitality was the brilliant comedy of Richard Brinsley Sheridan, which not only still holds the stage, but is accepted as the best type of English classical comedy.

Richard Sheridan

Sheridan was born in Dublin, of a clever Irish family, educated at Harrow, and inducted into society at Bath, where, at the age of twenty-one, unsupported by financial resources, he married a beautiful singer. Seeking fortune in London, he wrote, in his twenty-fourth year, the clever comedy *The Rivals*.

Then, with borrowed money, he obtained command of Drury Lane Theatre, and produced his brilliant *School for Scandal* and *The Critic*. In his twenty-ninth year he entered Parliament, and two years later became Under-Secretary for Foreign Affairs. He gained a great reputation by his orations against Warren Hastings, and by his defence of the French Revolution, followed by his demand for resistance against Napoleon as the subverter of the Revolution.

Sheridan died in 1816. He is buried in Westminster Abbey. His comedies retain their popularity, not only because they form an essential part of the drama of changing manners, but because their satire, biting, yet not ill-natured, remains lastingly true.

The theological writings of the century included Joseph Butler's *Analogy of Religion, Natural and Revealed*, published in 1736, a closely reasoned work made quite unnecessarily difficult by a clumsy style.

The lively *Letters from the East* of Lady Mary Wortley Montagu were written earlier than the period under notice, but were not published until 1763.

Memoirs and Letters

Horace Walpole's *Memoirs* and *Letters* will always remain a mine of information and interest for students of the more intellectual life of the period.

Fanny Burney, whose *Diary* was not published till far on in the 19th century (1842–46), gives delightful glimpses of literary and Court life, in a style which combines shrewd observation with ease and point in narration; and John Wesley's *Journal* has many phases of interest outside of the great religious movement he inspired and organised. J. D.

From a satirical print of 1790.

BURKE (i.e. Don Dismallo) RECEIVING PUNISHMENT FOR HIS APOSTASY.

Burke, at first a supporter of the French Revolution, published in November, 1790, his *Reflections*, which passed through eleven editions in a year and did much to check popular sympathy with the movement, to the dismay of his former associates. Above are shown (from left to right) Miss Williams, Dr. Price, Mrs. Barbauld, and Burke in the garb of a penitent, stripped to the waist, to receive the blows of Sheridan, Justice, Liberty, Lord George Gordon, Horne Tooke and Mrs. Graham.

Continued from page 388.

HISTORY:

Contributors:—J. A. Brendon, B.A.(Oxon.), F.R.Hist.S.; F. Collinson, F.R.Hist.S.; T. P. Evans, B.A.(Oxon.); James A. Manson; L. Stampa, M.A.(Oxon.); and J. B. Sterndale-Bennett.

BRITAIN'S STORY.—IX

[*The introductory chapter to* LORD MACAULAY'S *"History of England" has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages (printed in closer type) have been interpolated in order to meet the requirements of the student.*]

MANY persons who were warmly attached to the new opinions had, during the evil days, taken refuge in Switzerland and Germany. They had been hospitably received by their brethren in the faith had sat at the feet of the great doctors of Strasburg, Zurich, and Geneva, and had been, during some years, accustomed to a more simple worship, and to a more democratical form of church government, than England had yet seen.

Presbyterian Movement

These men returned to their country, convinced that the reform which had been effected under King Edward had been far less searching and extensive than the interests of pure religion required.

But it was in vain that they attempted to obtain any concession from Elizabeth; and since they could not be convinced, it was determined that they should be persecuted.

Persecution produced its natural effect on them. It found them a sect: it made them a faction. To their hatred of the Church was now added hatred of the Crown. The two sentiments were intermingled; and each embittered the other. Thus, as the priest of the Established Church was, from interest, from principle, and from passion, zealous for the royal prerogatives, the Puritan was, from interest, from principle, and from passion, hostile to them.

The power of the discontented sectaries was great. They were found in every rank; but they were strongest among the mercantile classes in the towns, and among the small proprietors in the country. Early in the reign of Elizabeth they began to return a majority of the House of Commons. And doubtless, had our ancestors been then at liberty to fix their attention entirely on domestic questions, the strife between the Crown and the Parliament would instantly have commenced.

But that was no season for internal dissensions. Roman Catholic Europe and reformed Europe were struggling for death or life. France, divided against herself, had, for a time, ceased to be of any account in Christendom. The English Government was at the head of the Protestant interest, and, while persecuting Presbyterians at home, extended a powerful protection to Presbyterian Churches abroad. At the head of the opposite party was the mightiest prince of the age, a prince who ruled Spain, Portugal, Italy, the Netherlands, the East and the West Indies, whose armies repeatedly marched to Paris, and whose fleets kept the coasts of Devonshire and Sussex in alarm.

Religion *v.* Patriotism

It long seemed probable that Englishmen would have to fight desperately on English ground for their religion and independence. Nor were they ever for a moment free from apprehensions of some great treason at home. For in that age it had become a point of conscience and of honour with many men of generous natures to sacrifice their country to their religion. A succession of dark plots, formed by Roman Catholics against the life of the Queen and the existence of the nation, kept society in constant alarm. Whatever might be the faults of Elizabeth, it was plain that, to speak humanly, the fate of the realm and of all reformed Churches was staked on the security of her person and on the success of her administration.

To strengthen her hands was, therefore, the first duty of a patriot and a Protestant;

and that duty was well performed. The Puritan, even in the depths of the prisons to which she had sent them, prayed, and with no simulated fervour, that she might be kept from the dagger of the assassin, that rebellion might be put down under her feet, and that her arms might be victorious by sea and land. One of the most stubborn of the stubborn sect, immediately after his hand had been lopped off for an offence into which he had been hurried by his intemperate zeal, waved his hat with the hand which was still left him, and shouted "God save the Queen!"

During the greater part of her reign, therefore, the Puritans in the House of Commons, though sometimes mutinous, felt no disposition to array themselves in systematic opposition to the government. But, when the defeat of the Armada, the successful resistance of the United Provinces to the Spanish power, the firm establishment of Henry the Fourth on the throne of France, and the death of Philip the Second, had secured the State and the Church against all danger from abroad, an obstinate struggle destined to last several generations, instantly began at home.

Spain and Tudor England

At the time when Elizabeth came to the throne England was confronted with many dangers and difficulties. The new queen's title was none too sure. The religious question was very weak. The country, moreover, without money and without resources, was engaged on the side of Spain in a war with France.

Philip II. of Spain was very anxious to maintain the English alliance, which he had secured by the marriage with Mary Tudor; and, in order still to preserve it, he now offered himself as a husband of Elizabeth.

But it was impossible for Philip to marry his deceased wife's sister unless first he could obtain a special dispensation from the Pope. Such a dispensation, however, the Pope was not willing to grant. On the contrary, being under the influence of France, he was carefully considering the advisability of impugning the legitimacy of the English queen.

Whatever doubts, therefore, Elizabeth may have had with regard to policy at the time of her accession it soon became clear to her that the defence of Protestantism at home, and power with France abroad, was essential to her own security and the independence of her realm.

Her first object was to effect a religious settlement. In this matter she reverted to the policy of her father, and aided by Matthew Parker, Archbishop of Canterbury, set to work again to free the English Church from the supremacy of Rome. At the same time, however, she was careful to preserve its Catholic foundation.

This policy, of course, suited neither the Calvinists nor the adherents of the old faith. It was manifestly a compromise, even more so than that which had been adopted by Henry VIII. But it was for this very reason that Elizabeth selected it. Any other policy, it seemed to her, must immediately drive one of the two religious parties in the country into open revolt; and that was a contingency which she wished to avoid at all cost, for tangled up among the religious controversy was a question with which she personally was intimately concerned—the dynastic question.

Elizabeth, in fact, was threatened with a great danger in that the next in order of succession to the English crown was Mary Queen of Scots (see the genealogical table, page 385), whom—as Elizabeth knew only too well—the Romanists in the country would gladly have seen upon the throne. Mary, moreover, had the support of the Puiscs, the most influential Catholic family in France at that time; and it seemed not unlikely that Philip of Spain would avenge the manner in which Elizabeth had spurned his advances, by championing the cause of the Scottish queen, and joining the Puiscs on a campaign to put down heresy in England.

Parliament begged and implored Elizabeth to marry, hoping that thereby she would not only strengthen her own position, but would ensure the succession. But whom could Elizabeth marry? In vain she considered the merits of the various eligible European princes. Not one of those princes satisfied requirements. If she married a Protestant she would destroy the hopes entertained by the Catholics for the ultimate peaceful accession of Mary. If she married a Catholic, her husband would have to be an insignificant person who could be of political use to her, or some powerful prince to whom she must sacrifice the independence of her position. And in either case she would offend her Protestant subjects.

Elizabeth's Matrimonial Projects

Thus, although many husbands were offered to her, each was politely refused. Elizabeth's personal preference inclined towards Robert Dudley, Earl of Leicester, but she wisely abstained from an alliance which she knew would be unpopular in the country. Instead, having assumed the role of the "Virgin Queen," she dallied with countless suitors, using marriage projects as political levers, and although she carried some of these affairs to a ludicrous extreme, she used them, one must admit, with remarkable cleverness.

The rapid progress of the Reformation in Scotland afforded Elizabeth a powerful weapon which she could use against Mary; and in January, 1560, she undertook to aid the Protestant nobles of Scotland in expelling the French whose influence in the country was then very strong. In return, she demanded an undertaking that Mary should renounce her pretensions to the English crown. Mary, however, refused to ratify this arrangement; and for the next few years the history of England was centred in a second war, waged with feminine astuteness, between Elizabeth and the Queen of Scotland.

In addition to succeeding to the throne of England Mary hoped also to win back Scotland to Catholicism.

From the portrait by Titian.

PHILIP II. OF SPAIN.

A remarkable portrait of the great Spanish ruler who was at one time the husband of a Queen of England. On the death of Queen Mary (1558) Philip, in the hope of preserving the English alliance, endeavoured to marry Queen Elizabeth, his deceased wife's sister. This project failed; and the Armada followed.

From the picture by Robert Herdman, R.S.A.

THE BEGINNING—A CONVENT GARDEN IN FRANCE.

When James IV. of Scotland died, leaving his throne to his daughter, Mary Queen of Scots was only six years old. In order that she might avoid an English alliance, the young Queen was sent to France, where she spent a happy childhood in a convent. In due course she was betrothed to the Dauphin, becoming in 1559 Queen of France. But in 1560 she was left a widow, and her tragic adventures began.

Accordingly she set about to find a husband who would help her to achieve this purpose, and in 1565 married her cousin, Lord Darnley (see genealogical table, page 385), a son of Henry VIII.'s niece, Margaret Douglas.

This marriage immensely strengthened Mary's claim to the English throne; and it was a heavy blow to Elizabeth when in 1566 her rival bore a son—the future James I. of England. In 1567, however, Darnley was murdered; and Mary, as a result of her subsequent marriage with the Earl of Bothwell, who was strongly suspected of the crime, altogether lost her hold on Scotland. For a while, therefore, Elizabeth was relieved of her anxieties.

But in the following year when Mary, forced by circumstances to flee from Scotland, crossed the border and threw herself on the protection of Elizabeth, the latter found herself again confronted by a difficult problem.

Eventually she decided to keep Mary in confinement in England. It was not a magnanimous action, but was characteristic of Elizabeth's habitual caution. Yet, even as a prisoner, Mary proved a powerful agent for mischief. A plot was soon set afoot to marry her to the Duke of Norfolk. Then came a dangerous rising in the north of England ostensibly in favour of the old religion.

By the end of 1569 this rebellion had been suppressed; but in 1570 the Pope again roused civil strife by excommunicating the Queen. Parliament retaliated in 1571 by passing repressive measures against the Catholics. In the meantime, however, the scheme for the liberation of Mary and her marriage to the Duke of Norfolk had gained in importance owing to foreign intervention.

As a result of negotiations carried out by one Ridolph, a Florentine banker resident in London, who acted as intermediary between the English conspirators, the Pope, and Philip II., it was agreed that the Duke of Alva should cross from the Netherlands to England at the head of an army. The plot, however, was discovered in time, and vigorous measures were adopted to frustrate it.

Philip II. was prevented by the state of affairs in the Netherlands and France from taking any further steps against Elizabeth for a time; and from 1572 to 1576 England was left in peace.

In latter years Philip II.'s half-brother, Don John of Austria, was sent as governor to the Netherlands. Now, Don John entertained ambitions not only of invading England but of marrying Mary

Queen of Scots, and, as her consort, of establishing himself ruler of England in Elizabeth's stead. He completely failed, however, in his endeavours to pacify the Netherlands. His greater schemes therefore, came to naught; and Don John died before his time, a broken, disappointed man.

The Reformation movement, which led to the breaking up of the alliance between England and Spain, led also to the revolt of the Protestants of Holland from the tyranny of Spain. England also was threatened by a life and death struggle with that same power; and this ultimately compelled Elizabeth to encourage the revolt of the Hollanders against their sovereign.

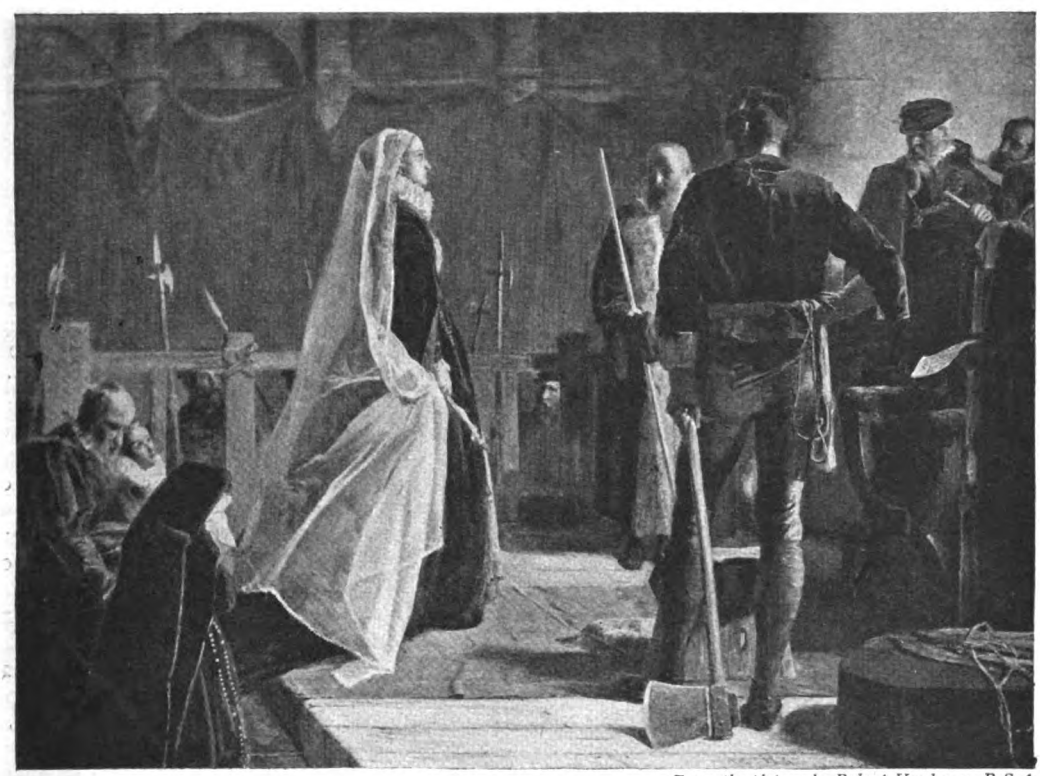
The English queen's direct interference in their affairs began with the lavish grants she made to the Duke of Anjou, brother of the French king, who assumed the sovereignty of the Netherlands and aspired to lead the southern provinces in their revolt from Spain. Elizabeth for a long while carried on negotiations with a view to marrying Anjou. By contracting such a union, she hoped to cement an alliance between England and France; and, had she been certain of securing this object, she would immediately have consented to the marriage.

But Elizabeth was by no means certain; she was uncertain as to the ability of Anjou; she was uncertain as to the attitude of France. In those circumstances she decided not to commit herself and, as a means of gaining time, affected great coyness towards her lover.

Events soon justified her doubts. Anjou failed utterly in the Netherlands; and France, under pressure of internal religious wars, was soon forced to withdraw all appearance of help from the Dutch. Elizabeth, therefore, despairing of a firm alliance between England and France, rejected the Duke of Anjou, and re-assumed her old role as the "Virgin Queen."

Elizabeth meanwhile was exposed to an almost incessant series of plots against her life, hatched by the Catholic party—the Jesuits in particular; and, as a result of those plots, the sentiment of loyalty to the Queen grew so strong among the people that a voluntary association was formed for her defence. Its members undertook to prosecute to death all who should attempt the queen's life, or on whose behalf such attempt should be made.

This latter clearly was a threat against Mary Queen of Scots; and since at this time the majority of the plots in her favour were Spanish in origin the hostility between England and Spain daily became more and more apparent.



From the picture by Robert Herdman, R.S.A.

THE END—FOTHERINGAY,

where, on February 8, 1587, the adventures of the beautiful but luckless Mary Queen of Scots were tragically ended. Expediency, the needs of England, left Queen Elizabeth with no alternative other than to bring about her rival's execution.

In the circumstances Elizabeth deemed it wise to send help to the Netherlands. But she sent as little as she could. She was unable to believe that the Dutch would make good their stand against Spain, and her sole purpose in assisting them at all was to induce them to do their best to prolong the struggle.

In 1585 the Earl of Leicester was sent to Holland with English troops. Leicester, however, did little more than lay siege to Zutphar; and Elizabeth, fully prepared to betray the Netherlands if thereby she could secure peace, soon reopened negotiations with Spain.

But Philip now refused to treat. He was irritated against England, partly on account of the help sent to the Netherlands, but still more on account of the damage done to Spanish trade in the West Indies by the piratical raids of Sir Francis Drake; and it was clear to all observers that the Spanish king was planning to invade and conquer England. Meanwhile the plots against Elizabeth's life were carried on as before.

At the end of 1586, a plot, contrived by one Antony Babington, was discovered. Sir Francis Walsingham, Elizabeth's trusted minister, allowed it to proceed until he had obtained evidence that implicated Mary Queen of Scots. Then he struck. Babington was executed, and a commission forthwith appointed to try Mary.

The unhappy queen was found guilty of the charges brought against her. For a long time, however, Elizabeth hesitated to put her to death; and when at last she signed the warrant, she gave no orders that it should be carried into effect.

Mary was beheaded in February, 1587.

The death of Mary brought the Spanish invasion very much nearer. During Mary's life-time, Philip had been forced to fight—ostensibly at any rate—not in his own, but in her name. On the Scottish queen's death, however, he was able to put forward his own claim to the English crown; and in May, 1588, sent out the "Invincible Armada" to conquer England.

Defeat of the Armada

The large, unwieldy ships that formed this fleet were singularly ill-suited for the work required of them. Moreover, the elaborate preparations which had been made for a junction with a fleet from the Netherlands came to nothing; and the great Armada was thrown into disorder by the small, speedy and well-handled craft of the English.

A storm completed the Spanish fleet's discomfiture; and England was saved from the long-threatened landing on its shores.

Of the huge fleet only a straggling remnant returned to the shores of Spain, after a wild and dangerous flight round the stormy coasts of the north of Scotland.

Now, as we have seen already, so long as this great menace hung over the country, political parties deliberately shelved their differences, and forgot their discontent, in order that the whole nation might present a firm and united front to the enemy.

The defeat of the Armada, however, insured the safety of the State and of the Protestant Religion. England no longer stood in danger of becoming a Spanish province; and, almost immediately, the opposition which for forty years had been silently gathering and husbanding its strength raised its voice against the government.

It was in the Parliament of 1601 that the opposition which had, during forty years, been silently gathering and husbanding strength, fought its first great battle and won its first victory.

The ground was well chosen. The English sovereigns had always been entrusted with the supreme direction of commercial police. It was their undoubted prerogative to regulate coin, weights, and measures, and to appoint fairs, markets, and ports.

Monopoly Patents

The line which bounded their authority over trade had, as usual, been but loosely drawn. They therefore, as usual, encroached on the province which rightfully belonged to the legislature. The encroachment was, as usual, patiently borne, till it became serious. But at length the Queen took upon herself to grant patents of monopoly by scores. There was scarcely a family in the realm which did not feel itself aggrieved by the oppression and extortion which this abuse naturally caused. Iron, oil, vinegar, coal, saltpetre, lead, starch, yarn, skins, leather, glass, could be bought only at exorbitant prices.

The House of Commons met in an angry and determined mood. It was in vain that a courtly minority blamed the Speaker for suffering the acts of the Queen's Highness to be called in question. The language of the discontented party was high and menacing, and was echoed by the voice of the whole nation. The coach of the chief minister of the crown was surrounded by an indignant populace, who cursed the monopolies, and exclaimed that the prerogative should not be suffered to touch the old liberties of England.

There seemed for a moment to be some danger that the long and glorious reign of Elizabeth would have a shameful and disastrous end. She, however, with admirable judgment and temper, declined the contest, put herself at the head of the reforming party, redressed the grievance, thanked the Commons, in touching and dignified language, for their tender care of the general weal, brought back to herself the hearts of the people, and left to her successors a memorable example of the way in which it behoves a ruler to deal with public movements which he has not the means of resisting.

Continued from page 411.

SCIENCES:

Contributors:—ANTHROPOLOGY AND ETHNOLOGY (Sir H. H. Johnston, G.C.M.G., K.C.B.). ASTRONOMY (Arthur R. Hinks, M.A., F.R.S.). BOTANY (E. W. Edmunds, M.A., B.Sc.[Lond.]). CHEMISTRY (E. H. Tripp, Ph.D.). ELECTRICITY AND MAGNETISM (L. M. Parsons, M.Sc., D.I.C., F.G.S.). GEOLOGY AND MINERALOGY (Arthur Holmes, D.Sc. [Lond.], A.R.C.S., D.I.C., F.G.S.). PHYSIOLOGY (Sir Malcolm Morris, K.C.V.O., and D. W. Carmalt-Jones, M.A., M.D.[Oxon.]). SOUND, LIGHT, AND HEAT (E. W. Edmunds, M.A., B.Sc. [Lond.]). ZOOLOGY (E. A. Bryant and Ashley G. Brown, F.Z.S.).

CHEMISTRY.—XXIV

Silica.—THE element silicon belongs to the same chemical family as carbon, but, unlike it, is of little service to man. The oxide, silica, SiO_2, is, however, a very important substance, occurring very widely in nature and being most useful in the arts and industries, particularly for the manufacture of glass, pottery, and porcelain. Of the naturally occurring forms of free silica quartz, rock crystal, sand, sandstone and tridymite are crystalline, and flint, jasper, jet, agate, chalcedony and siliceous earth are amorphous. These various forms of silica are chemically identical, and differ chiefly in their structure and in their varying content of small quantities of impurities.

A very large number of rocks and minerals is composed of silicates, i.e. of compounds of silica and metallic (Al, Ca, Mg, K, Na, etc.) bases; they include felspar, clays, mica, hornblende, asbestos, and talc. Chemically pure silica is obtained in the amorphous state by fusing sand, glass or other silicate with sodium carbonate. $SiO_2+Na_2CO_3=Na_2SiO_3+CO_2$. The fused mass is treated with water and filtered; the filtrate containing the sodium silicate is evaporated down to dryness with hydrochloric acid, treated with water, filtered, thoroughly washed and then dried. $Na_2SiO_3+2HCl=SiO_2+H_2O+2NaCl$.

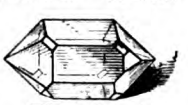


Fig. 40.—A Quartz Crystal.

Silica is a remarkably stable substance towards heat and chemicals. Its melting point is above 1600°, and the molten material can be drawn out to very fine threads which are useful for the suspension of galvanometer needles. Glass vessels may be replaced by silica ware; the latter is, however, more expensive and less transparent than the former, but it withstands sudden changes of temperature to a remarkable degree, and it is very resistant towards water, alkalis and acids. Being quite insoluble in all ordinary solvents, silica is brought into solution by fusion with an alkali carbonate, soluble alkali silicate being formed. "Water glass," used for preserving eggs, is a hydrated form of sodium silicate. A number of silicates of different composition is known; thus Na_2SiO_3 is called sodium metasilicate, and Na_4SiO_4, sodium orthosilicate.

Such salts are derived theoretically from meta- and orthosilicic acids, H_2SiO_3 and H_4SiO_4, neither of which is known in the free state. A solution of sodium silicate reacts strongly alkaline, because it contains free alkali, the salt being to some extent decomposed by the water ("hydrolysed"), forming some caustic soda and a sodium silicate containing relatively more of the acid radical. The aqueous solutions of all salts compounded of a strong base (e.g. NaOH, KOH, $Ca(OH)_2$) and a weak acid (e.g. H_2CO_3, HNO_2, H_2S) show a similar alkaline reaction towards litmus, and for a like reason. When sodium silicate and hydrochloric acid are mixed in concentrated solution, a white gelatinous precipitate of hydrated silica is formed; but in dilute solution no such precipitation occurs and the liquid then contains, in addition to sodium chloride, "colloidal" silicic acid.

In a colloidal solution the substance is not dissolved in the strict sense of the term, but exists as extremely small (ultramicroscopic) particles in a state of suspension. With the exception of alkali silicates, all metallic silicates are insoluble in water; they may be brought into solution by treatment with hydrofluoric acid (HF) or by fusion with an alkali carbonate.

Experiment LXXV.—*Preparation of Silica.*

(i) A specimen of pure silica should be made in the manner described above. About 2 grms. of sand and 10-12 grms. of carbonate (preferably a mixture of sodium and potassium carbonates, called "fusion mixture") are taken and heated to a high temperature in a porcelain crucible. (ii) To a dilute solution of "water glass" add hydrochloric acid: there is no precipitate. Add the same acid to a concentrated solution: a precipitate of gelatinous silica is formed. If this be filtered off, washed, dried, and ignited, amorphous silica is again obtained.

Glass is essentially a mixture of silicates artificially prepared. It is made by fusing pure white sand or crushed quartz with oxides or salts of potassium, sodium, calcium, lead and sometimes barium or zinc. These compounds react with the silica to form the metallic silicates; thus $CaCO_3+SiO_2=CO_2+CaSiO_3$. The fusion is performed in a fire-clay pot, the glass is removed on the end of an iron tube and given the required shape by blowing into the tube, by swinging or rolling it, or by rotating it in a mould. It is then annealed in a special kiln to prevent it becoming too brittle.

Window, plate, table, bottle, and ordinary "soft" glass contain sodium and calcium silicates. The lustrous, highly refractive flint glass is made from nitre or potassium carbonate, red lead and silica. The so-called "hard" glasses, e.g. Bohemian and Jena ware, contain potassium and calcium silicates. To obtain a coloured glass certain metallic oxides are added, thus an iron compound imparts a green colour, and a cobalt compound a blue. Boric acid is much used in the manufacture of optical glass.

Phosphorus.—We are already familiar with this element as a very active substance which ignites at a low temperature. It is also remarkable because it glows in the dark, the phenomenon being due to slow combustion. It occurs almost exclusively as calcium phosphate, $Ca_3(PO_4)_2$; enormous quantities of this phosphatic rock are found in the United States, and in the north of Africa (Tunis). This same compound forms the mineral basis of all animal bones, from which it is extracted by destructive distillation, and it is found in all living tissues. Phosphorus compounds form an essential constituent of all fertile soils.

The manufacture of phosphorus from bone-ash or from native phosphate is largely a commercial secret. The modern electric process consists in heating a mixture of calcium phosphate, coke and finely divided silica in an electric furnace out of contact with air. Calcium phosphate and silica react to produce calcium silicate and phosphoric oxide; the latter is reduced by the coke and the liberated phosphorus vapour is led off through a tube in the upper part of the furnace. In the lower part is a tap-hole through which the molten calcium silicate is run off. The phosphorus is collected in water, purified and then cast, still under water, in cylindrical moulds.

Phosphorus exists in several allotropic modifications, of which the ordinary or yellow phosphorus and red phosphorus are the more important.

Yellow phosphorus is translucent and nearly colourless when freshly prepared, but it becomes opaque and dark on the surface after exposure to light. It is crystalline and hard at 0° C.; at 16° C. it is soft. It melts under water at 44° C., and it boils at 290°, giving a colourless vapour. It is volatile with steam, i.e. when boiled with water it passes off in the steam. Unaffected by water, it is fairly readily dissolved by carbon disulphide, and from its solution octahedral crystals may be obtained on evaporation. The smell of this element is really the smell of ozone, O_3, which is formed by the action of the smouldering phosphorus upon the oxygen of the air. The ignition temperature is about 30°, and hence it is always kept under water. If a little solution of phosphorus (VE) be poured upon filter-paper, the latter catches fire spontaneously in a few minutes.

All experiments with phosphorus must be performed with great care, for it is not only very inflammable, but also very poisonous; it is chiefly used for match-heads and as a vermin poison. The antidote is copper sulphate solution (1 grm. in 500 c.c. water). The outstanding chemical feature of phosphorus is its reducing power. It burns in air or oxygen, forming phosphoric oxide, P_2O_5, and in a limited supply of air, phosphorous oxide, P_4O_6, is also produced. It reduces nitric acid with energy, precipitates gold from solutions of its salts, and reduces sulphuric acid and copper sulphate.

Red phosphorus is formed when the yellow variety is heated out of air to 250-300°, but the addition of a trace of iodine reduces the temperature of transformation to 200°. The properties of this allotrope are very different from those of ordinary phosphorus. Chemically it is far less active, being permanent in air and not easily ignited. At about 260° combustion ensues owing to conversion into the yellow form. It is not poisonous, is insoluble in carbon disulphide, does not combine with chlorine unless heated, and is unaffected by warming with alkalis. Its sp. gr. is 2·25, that of yellow phosphorus 1·83. Its main use is in the preparation of the striking surfaces of safety matchboxes.

The original "chemical match" (1812) was made by dipping wood into molten sulphur and coating the head with a mixture of sugar and potassium chlorate. It was ignited by dipping into a bottle containing asbestos soaked in sulphuric acid.

To make the modern friction match, the wood is soaked in melted paraffin wax and afterwards dipped into a paste of yellow phosphorus, glue, colouring matter, and an oxidising agent like red lead, manganese dioxide or nitre. The head of the safety match contains no phosphorus, but antimony sulphide, potassium chlorate and glue.

Oxides and Oxy-acids of Phosphorus.—The oxygen compounds of phosphorus are very numerous; they comprise:

Oxides.

Phosphoric oxide, P_2O_5 (or P_4O_{10}).
Phosphorous oxide, P_2O_3 (or P_4O_6).

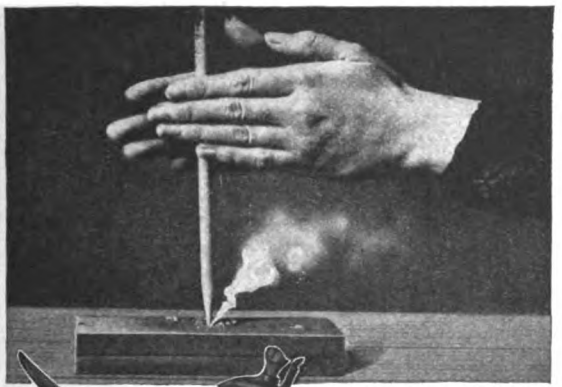
Acids.

Orthophosphoric acid, H_3PO_4.
Metaphosphoric acid, HPO_3.
Phosphorous acid, H_3PO_3.
Hypophosphorous acid, H_3PO_2.

Salts.

Orthophosphates.
Metaphosphates.
Phosphites.
Hypophosphites.

Phosphoric oxide, much used for making "smoke clouds" in modern warfare, is a voluminous white powder which sublimes when heated. Its vapour density corresponds with the formula P_4O_{10}, but the simpler formula P_2O_5 is usually employed. It



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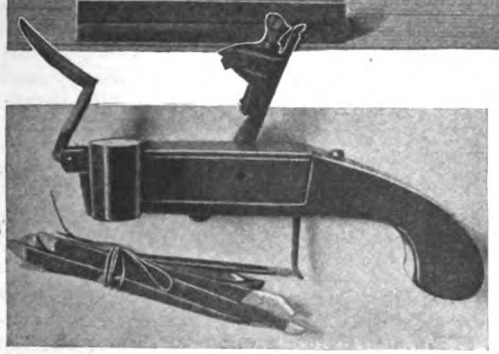

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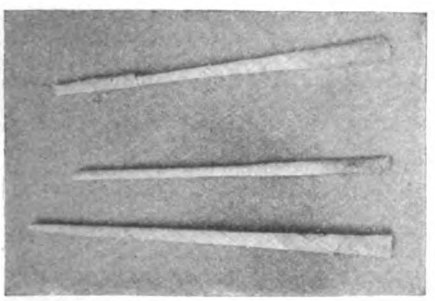

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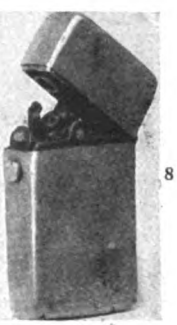


8

THE EVOLUTION OF THE MATCH

has been a very gradual process. Primitive man kindled a light by (1) friction of hard and soft wood. This method was superseded by the use of flint and steel. Above are shown three examples :— (2) a Chinese outfit, (3) a flint lock, and (4) an eighteenth-century tinder box. The first chemical matches (5) were produced in 1812. Congreve's sulphur matches (1827), the first practical lucifer matches, (6) paved the way to the modern safety. Also shown above are (7) the fusee and (8) the modern petrol lighter.

is exceedingly hygroscopic and is much used as a drying agent. With cold water it forms metaphosphoric acid, $P_2O_5+H_2O=2HPO_3$; and with hot water, orthophosphoric acid, $P_2O_5+3H_2O=2H_3PO_4$.

The meta-acid, or "glacial" phosphoric acid, is a transparent glass-like solid, which melts at 0° and is very soluble in water. Boiled with water it gives the ortho-acid, $HPO_3 + H_2O = H_3PO_4$. Orthophosphoric acid is prepared either by oxidising red phosphorus with nitric acid, or by treating calcium phosphate with the theoretical quantity of diluted sulphuric acid (1 : 1), filtering off the calcium sulphate and evaporating, $Ca_3(PO_4)_2+3H_2SO_4=3CaSO_4+2H_3PO_4$. It is also very soluble in water, and from its solution six-sided crystals of H_3PO_4, which melt at 38·6°, may be obtained. At 215° it gives water and pyrophosphoric acid, $2H_3PO_4=H_2O+H_4P_2O_7$; at a still higher temperature metaphosphoric acid is produced, $H_4P_2O_7=2HPO_3+H_2O$.

Orthophosphoric acid is tribasic, yielding three salts with monovalent metals, e.g. NaH_2PO_4, sodium dihydrogen phosphate, acid to litmus; Na_2HPO_4, disodium hydrogen phosphate (the ordinary phosphate of soda), neutral to litmus; and Na_3PO_4, trisodium phosphate, alkaline to litmus. These salts are made by the action of caustic soda on phosphoric acid solution. Orthophosphates give a yellow precipitate of silver phosphate, Ag_3PO_4, with silver nitrate in neutral solutions.

Phosphorous oxide is a white crystalline solid of low melting point (22·5°). From its vapour density the formula P_4O_6 is deduced, and it is often called phosphorous anhydride because it yields phosphorous acid with water, $P_4O_6+6H_2O=4H_3PO_3$. On exposure to air it is oxidised to phosphoric oxide, $P_4O_6+2O_2=2P_2O_5$; in warm oxygen it bursts into flame. Both phosphorous acid and its salts, the phosphites, are good reducing agents, as they unite with oxygen to form phosphoric acid and phosphates.

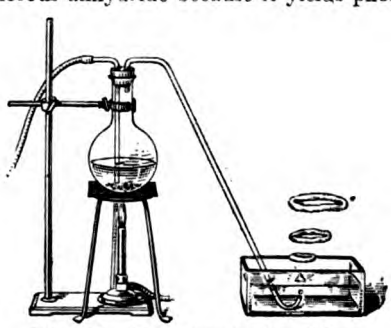


Fig. 41.—To prepare phosphine.

Phosphine, or Phosphuretted Hydrogen, PH_3, is a colourless, unstable, poisonous gas with an offensive odour like that of putrid fish. It is evolved when phosphorus is heated with a strong solution of caustic alkali in a neutral atmosphere, e.g. coal gas or carbon dioxide, $4P+3NaOH+3H_2O=PH_3+3NaH_2PO_2$ (sodium hypophosphite). This gas exhibits the interesting property of spontaneous inflammability, bursting into a bright flame in contact with air, and forming water and white fumes of phosphoric oxide, $2PH_3+4O_2=P_2O_5+3H_2O$. This property, however, does not belong to pure phosphine; it is due to the presence of a small amount of liquid phosphine, P_2H_4, and when this impurity is removed by passing the gas through alcohol or a well cooled tube there is no ignition on contact with air. Phosphine is a good reducing agent, precipitating many metals from their solutions as phosphides.

The composition of phosphine reminds us of that of ammonia, NH_3, and in view of the many similarities in chemical behaviour between nitrogen and phosphorus it might be anticipated that phosphine would possess basic properties. Although it is not alkaline to litmus, nevertheless it unites with certain acids to form salts; thus phosphorium iodide, PH_4I, is produced by the combination of phosphine with hydrogen iodide (similar to hydrogen chloride), and it is strictly analogous to ammonium iodide, NH_4I, and ammonium chloride, NH_4, although far less stable.

Experiment LXXVI. — *Experiments with phosphorus and its compounds.*

(i) A small piece of phosphorus is dissolved in carbon disulphide in a dry test-tube, and the solution poured over a dry filter-paper.

(ii) Another small piece is placed in contact with a few crystals of iodine on the bottom of an inverted mortar. The elements unite to form phosphorus iodide.

(iii) Some carefully dried phosphorus is burnt in a small dish resting on a dry glass plate and covered with a dry bell-jar. The phosphoric oxide is scraped together and put into cold water, the resulting solution being tested with litmus.

(iv) A few small pieces of the element are placed in a gas-jar nearly filled with hot water and oxygen is introduced through a tube. The phosphorus burns, but owing to the limited supply of gas much red phosphorus is produced.

(v) Three grms. of red phosphorus are introduced in small doses to 40 c.c. of nitric acid (sp. gr. 1·2), contained in a dish. The mixture is gradually heated to boiling, and when the reaction is complete the liquid is concentrated by evaporating at a temperature not exceeding 180°.

(vi) A dilute solution of caustic soda is run from a burette into 10-20 c.c. of phosphoric acid solution until neutralisation is effected. If the liquid be crystallised, it deposits crystals of $Na_2HPO_4.12H_2O$. To the same amount of acid, half the volume of alkali used in the first case is added; on evaporating to a low bulk, crystals of $NaH_2PO_4.H_2O$ gradually separate. To a third equal portion of acid, 1½ times the original amount of alkali is added, and the liquid crystallised, $Na_3PO_4.12H_2O$, crystallises out after a long time.

(vii) To prepare phosphine, some phosphorus is put into a concentrated solution of caustic soda contained in a medium-sized flask, which is fitted with a double-bored cork carrying a delivery tube in communication with a trough of water, and another tube connected to the coal gas supply and dipping down well into the liquid. The air in the apparatus is first displaced by coal gas, and then the flask is gradually heated up, a gentle current of gas passing through it continuously. When the phosphine appears it should be made to emerge through a beehive shelf immersed in the water, and the gas current should be stopped or much reduced. Good vortex rings of phosphoric oxide will be obtained. The flask and contents must be cooled down subsequently in a current of coal gas. E. H. T.

ELECTRICITY AND MAGNETISM.—XII

Measurement of Current by the Tangent Galvanometer.—It will be sufficient for most of our experiments if we merely *compare* different currents by means of the Tangent galvanometer, but one may reasonably ask if this instrument can be used to measure a current in definite practical units.

It can certainly be employed for such a purpose by our using the important equation C = K tan A. Translated into words the equation means that current strength (in absolute units) equals the tangent of the angle of deflection multiplied by a certain quantity expressed by the symbol K. We now know how to note an angle of deflection, and turn up its tangent from the list, but what is K, and how are the absolute units of current related to Ampères? Let us deal with K first. The diameter of the copper or brass circle of the galvanometer influences the degree of magnetic influence of the current upon the magnet in the centre of the instrument, so that the size of the copper circle has something to do with the quantity expressed by K. But that is not all. The earth's magnetic influence in a horizontal direction has to be considered. Hence the symbol K represents a quantity depending upon the size of the galvanometer circle and the earth's horizontal directive force. If you were to buy a tangent galvanometer, the value of K for that special instrument would be supplied, but in the case of the home-made instrument the value of K must be found by experiment.

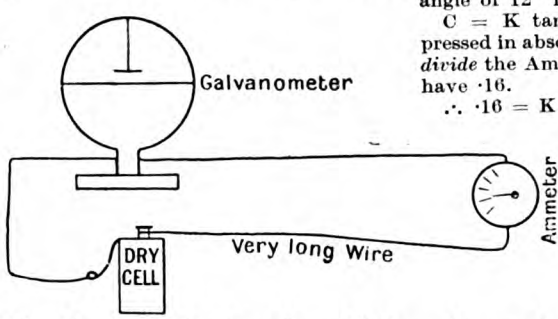


Fig. 41.—To obtain the value of K for a home-made galvanometer.

Now with regard to the absolute units and Ampères. In practice Ampères are always used, and the theoretically interesting absolute unit of current strength is equal to ten Ampères. This being the case it must be remembered that the strength of any current found by means of the tangent galvanometer and the equation C = K tan A must be multiplied by 10 to convert the number into Ampères.

Let us consider an example to which reference may be made after the value of K for the home-made galvanometer has been found. Find the current in Ampères given that the value of K is ·108 and the angle of deflection is 25°. The tangent of 25° is given in the list as ·466.

Now C = K multiplied by tan A.

$\therefore$ C = ·108 × ·466

$\therefore$ C = ·05 (roughly)

i.e. the current strength is ·05 in absolute units. Multiply by 10 to express the current in Ampères, and we obtain ·5 as the answer. The current is half an Ampère.

The student will have noticed that if the current strength is known, and the tangent of the angle can be found, then the value of K may be obtained by dividing the current strength (in absolute units) by the tangent of the angle. This will be quite clear if we bear in mind that C, K, and tan A are actual numerical quantities. Just as 12 = 3 × 4, so C = K × tan A, and as 3 = 12 divided by 4 so K = C divided by tan A.

Experiment 34.—*To obtain an approximate value of K for the home-made galvanometer.*

Take your dry cell to an electrician or a garage and have the number of Ampères determined by means of an ammeter, being careful to see that short thick wires make the connections between the terminals of the cell and those of the ammeter, in fact, the wire connections you are going to use for joining the cell to the tangent galvanometer should be used.

Make a note of the Ampères and do not use the cell again till you perform the experiment. Suppose the number of Ampères to be 1·6. Now set the galvanometer, fix up the connections and note the angle of deflection when the pointer is steady. Suppose that this angle is 12°. Find the tangent of an angle of 12° from the list. It is ·213.

C = K tan A, and C must be expressed in absolute units. In this case *divide* the Ampères (1·6) by 10, and we have ·16.

$\therefore$ ·16 = K multiplied by ·213.

$\therefore$ K = ·16 divided by ·213.

and this worked out gives K = ·075.

K is known as the *Working Constant* of the galvanometer, and once the value of it is known, currents can be measured in Ampères by means of the instrument. If the student has an ammeter at his disposal the experiment can be performed more accurately by having both the tangent galvanometer and the ammeter in the circuit, only in this case *long wires* must be used since the near presence of an ammeter will influence the reading of the galvanometer. Also care must be exercised to see that the current is sent through the ammeter in the right direction, the wire from the carbon plate of the cell being attached to that terminal of the ammeter marked with a + sign.

The arrangement of the apparatus should then be as illustrated in Fig. 41.

Experiments Illustrating Resistance.—Having a means of comparing currents resulting from E.M.F. versus R. as expressed by Ohm's Law, we may gain further information about resistance before experimenting on Electro-Motive-Force.

Wires, particularly those made of copper, are necessary for experimental purposes, and those mentioned below should form part of the student's apparatus in this respect:—

One yard each of fairly thick copper, iron, and platinoid wire. These should be all of the same gauge, and of uniform thickness. A few yards of much thinner copper and iron wire.

Experiment 35.—*To compare the resistances of different metals.*

In making these experiments, a cell supplying a constant current should be used, hence a dry cell will be better than either a Leclanché or a dichromate cell.

Set the tangent galvanometer and to one end of the conducting circle attach a short piece of thick copper wire, the other end of which should be attached to one terminal of the dry cell. To the other terminal of the cell attach exactly one yard of the thick copper wire. Without shaking the galvanometer complete the circuit by pressing the other end of the yard of wire against the conducting circle of the galvanometer. Note the angle of deflection through which the needle of the galvanometer moves. When it is steady note the reading and find the tangent of the angle by means of the list.

Now substitute the yard of thick iron wire of similar gauge in place of the copper wire.

Again complete the circuit and record the resulting angle and its tangent. Next perform an exactly similar experiment with the platinoid wire. Your results should be recorded in tabular form.

Material of wire.	Angle.	Tan A.
Copper	° ..	.. .
Iron	° ..	.. .
Platinoid	° ..	.. .

The variations in the tangents will indicate the alterations in the current when wires of different materials are used. The copper, iron, and platinoid wires are all of the same length and thickness, hence length and thickness have nothing to do

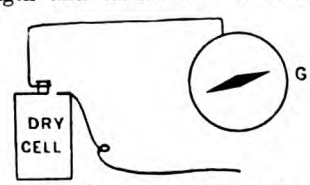


Fig. 42.—To compare the resistances of different metals.

with the alteration in current in this experiment. It is obvious that the variations in current strength are due to the fact that different metals offer different resistances to the passage of the electric current.

The resistance offered by any conductor in virtue of the species or kind of matter of which it is composed is called Specific Resistance. The converse of resistance is conductance, hence a material which has a high specific resistance has a low conductance, and vice versa. Silver and copper are better conductors than other metals, but they are expensive, especially the first named. Since electricity appears to flow along the surface of conductors, an iron wire covered by a surface layer of copper makes a better conductor than a solid iron wire.

Experiment 36.—*To find the relation between the length of a conductor and its resistance.*

Set the galvanometer as before, attach one end of the conducting circle to one terminal of the dry cell. The other terminal of the cell should be connected with a fair length, say one and a half yards, of thick copper wire, the other end of which must remain free. Arrange about two yards of thin iron wire along the table with one end of it attached to the galvanometer as illustrated in the diagram.

The circuit can be completed by bringing the free end of the copper wire attached to the cell in contact with *any portion* of the iron wire. First make the contact at a point A near the galvanometer, and then slide it along the iron wire.

Note the variations in the deflection of the galvanometer needle as the different lengths of iron wire are included in the circuit. The copper wires do not vary in length, but the iron wire does, and as the length of the iron increases the current becomes weaker.

Thin wire of any other metal may be substituted for the iron wire, and similar results will be obtained, from which we infer that the longer a conductor is the greater its resistance. This fact is usually expressed by saying that *with conductors of constant thickness and material, the resistance varies directly to the length.*

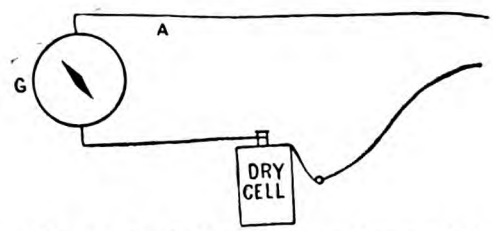


Fig. 43.—To find the relation between the length of a conductor and its resistance.

Experiment 37.—*To observe the relation between the thickness of conductors and resistance.*

Set the galvanometer and attach it to one terminal of the dry cell as in the other experiments. Connect the galvanometer with the other cell terminal by exactly one yard of thick copper wire. Note the angle of deflection and its tangent.

Now remove the yard of thick wire and substitute exactly one yard of thin copper wire. Again note the deflection and its tangent. The current is weaker when the thin wire is in the circuit than it is when the thicker copper wire is used. The lengths and material of the wires being the same, it is evident that thin wires offer greater resistance than thick wires.

Experiments have shown that in the case of wires having circular cross sections (i.e. "round" wires) *the resistance varies inversely as the area of cross section.*

We may summarise the results of the preceding experiments on resistance by saying that the resistance of a given uniform and undivided conductor depends upon the material of which it is composed, its length and its area of cross section.

What happens in the case of a divided circuit or one in which the current has more than one pathway available, will be seen in later experiments.

Any electric cell has an internal resistance, the amount of which depends upon certain conditions.

This may be said of any current producing apparatus. A dynamo has an internal resistance due to the wires of the armature, etc. In the case of cells, a great deal depends upon the nature of the substances used for purposes of anti-polarisation. A solid anti-polariser such as the powder manganese dioxide used in Leclanché cells, offers more resistance than fluids.

Experiment 38.—*To observe certain conditions which determine the internal resistance of a cell.*

For this purpose we may use a simple cell. Remove the copper and zinc plates from the acid and connect each plate to one end of the copper circle of the galvanometer. See that the instrument is properly set in the magnetic meridian, and then just dip the lower ends of the cell plates in the acid solution without allowing them to touch each other. Gradually note the variation in the deflection of the

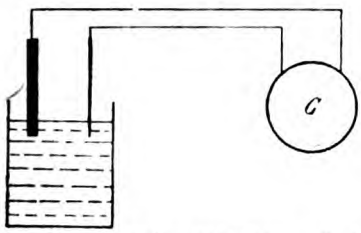


Fig. 44.—To determine conditions which form the internal resistance of a cell.

galvanometer as you slowly immerse the plates, *keeping them the same distance apart.* The current increases as the plates sink deeper into the solution. When the plates are wholly immersed, gradually bring them nearer to each other and note the galvanometer deflections. The current is stronger when the plates are nearer to each other than when they are further apart.

From this experiment we conclude that *the larger the plates of a cell the lower is its resistance, and the further apart the plates are, the higher the resistance of a cell.* L. M. P.

BOTANY.—VI

16. The Mineral and Organic Contents of the Soil.—THE basis of a sandy soil is the crystalline mineral, silica or quartz, which, being insoluble in water, does not enter the plant except in one or two particular cases. But few sands are pure : most of them are red, for instance, owing to the presence of oxide of iron, which is soluble in acid waters, and hence may enter the plant. Iron, in fact, is absolutely essential in small amounts ; without it the green colouring matter of the plant cannot form.

Clay is composed of a silicate of alumina, insoluble in water, and in this case also it is the impurities that are valuable to plants. We may say in general that the main body of an ordinary soil is useless to growing plants.

DEMONSTRATION XIX

(i) To test this, fill a flower-pot with some clean well-washed silver sand, and sow some mustard seeds on it. Keep it watered, and study the fate of the seedlings carefully. Compare with seedlings grown in a pot containing sand mixed with a tablespoonful of humus from a good garden soil.

(ii) Take a little *red* sand in a test-tube, and shake well with diluted hydrochloric acid. Filter, and notice the effect of the acid. Has it changed the sand itself ? Treat thus clay and chalk soils.

It thus appears that the most important constituent of the soil from the plant's point of view is the humus. Many familiar facts show that humus is formed from decaying animal or vegetable matter. Its accumulation under trees where the leaves and twigs decay *in situ ;* the fact that a farmer will often plough into the ground crops of charlock and other valueless plants ; the effect of stable-manure or of horse-dung in a garden—these all tell the same tale that humus is the product of animal or vegetable decay.

DEMONSTRATION XX

To examine the matter experimentally—sow some mustard seeds in a series of small pots containing respectively : (A) Samples of soil from your neighbourhood—(*a*) unaltered ; (*b*) mixed with some snippings of dead plants ; (*c*) mixed with a little horse-dung. (B) Samples of the subsoil similarly treated. There will thus be six pots which must be exposed to the same conditions. Comparing the results day by day, it will be noticed that the A experiments are always better than those corresponding to them in B, and that the seedlings in Ac are usually better than those in A*b*, and these in turn better than the A*a* set. These last differences are usually more pronounced in the B series, where there was no humus to start with.

The results of this experiment are very striking and important. They reveal not only the value of decaying organic matter, but the fact that its influence is greater in the soil itself than in the subsoil. In other words, the soil can utilise more of the organic manure than the subsoil can. This is now known to be due to the presence of certain micro-organisms, called the *nitrification bacteria*, in the soil ; without which the last steps in the process of decay cannot be carried out. Left to decay by itself in the presence of air, organic matter is finally resolved into carbonic acid gas (CO_2), water, and ammonia (NH_3). Now, this last substance apparently cannot be used by the plant as such ; it is therefore changed by the nitrification bacteria, first into nitrous acid (HNO_2), and then into nitric acid (HNO_3), which unites with any alkali that may be present in the soil—e.g. potash or lime—to form *nitrates.* These nitrates then become an invaluable and necessary food for the plant. We must therefore conceive the soil as a kind of nitrate factory, in which the vital action of peculiar bacteria is slowly changing the organic substances present in it into the indispensable nitrates upon which the plant lives. The ordinary plant, in fact, gets all its nitrogen from this source, and nitrogen

is of course one of the fundamental elements of protoplasm. Observe that the nitrification process needs oxygen : hence it will be most rapid in open sandy soils. The first stages in the formation of humus go on best in the absence of oxygen, but aeration is indispensable for the later stages.

DEMONSTRATION XXI

(i) Take four small flasks A, B, C, D, fitted with good corks. Into A and B put a little fresh milk ; into C and D a little lime-water. Enclose a little muslin bag in each flask as represented in Fig. 35. Tie up in the bag a little of the black surface soil in A and C ; in B and D tie a little of the same soil which has been heated to redness for ten minutes, so that both the humus and the bacteria in it are destroyed. After one or two days, you will then notice—in A, the milk has curdled and gone sour ; in B, the milk remains unchanged ; in C, the lime-water becomes milky on being shaken, but not in D. Explain the reasons for these changes. A drop of the milk from A will be seen, under a good microscope, to be swarming with bacteria (Fig. 36).

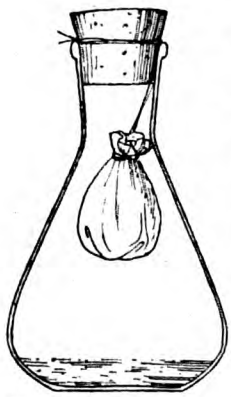


Fig. 35.—To observe the various stages in the formation of humus.

Fig. 36.—A drop of milk seen under a microscope.

(ii) Half fill each of two beakers with moistened silver sand ; into one of them pour a small amount of a solution of saltpetre (potassium nitrate). Sow some mustard seeds on each, and study the effect of the nitrate on the seedlings.

Though the nitrates are the most important, they are not the only substances that the soil must supply to the plant. A chemical study of the ash left behind when plants are burned shows that sulphur, phosphorus, potassium, calcium, magnesium and iron are universally present ; without them plants do not grow healthily, and special plants require special substances in addition. These elements are obtained from the soil in suitably combined form. We cannot go fully into the matter here, but it may be said that they may usefully be added to the soil as manures in the form of calcium or magnesium sulphate, calcium phosphate (i.e. the ash of bones, used in commerce in the soluble form as superphosphate of lime), potassium sulphate and other substances. Nitrates are often added as nitrate of soda (Chili saltpetre) or nitrate of lime : sometimes sulphate of ammonia is used. Most of these substances are very soluble, but the soil has a considerable power of retaining them even in wet weather. In Nature they are of course formed chiefly from previous vegetation, but the mineral substances may also be increased from the subsoil. The presence of potash, lime and magnesia in plant-ashes is important for another reason : they are bases, and neutralise the acids formed in the humus, which would prevent the absorption of liquids by the plant entirely.

DEMONSTRATION XXII

In order to examine the value of these substances to the plant, *water-cultures* can be made. For this purpose the following solutions should be prepared : potassium nitrate (1 gramme per litre of water) ; calcium sulphate ($\frac{1}{2}$ gramme per litre) ; magnesium sulphate ($\frac{1}{2}$ gramme per litre) ; potassium phosphate ($\frac{1}{2}$ gramme per litre) ; sodium chloride ($\frac{1}{2}$ gramme per litre). A complete *culture-solution* will contain equal quantities of these solutions diluted to double the volume with water. A drop or two of iron chloride is also necessary.

To use the solution, take an active seedling of wheat or pea ; fit it loosely through a cork, and allow its roots to hang in the solution contained in a flask (Fig. 37). A series of similar seedlings grown in solutions from which one of the ingredients is missing will illustrate the effect of the respective omissions. It will be easy to observe that the loss of the nitrate is most injurious, but that the absence of any of the other ingredients has also harmful consequences. The experiment is not always easy, owing to the tendency of the mixed solutions to alter on keeping, and to the development of bacteria injurious to the seedlings. But it is easy to see when the results are vitiated from either of these causes.

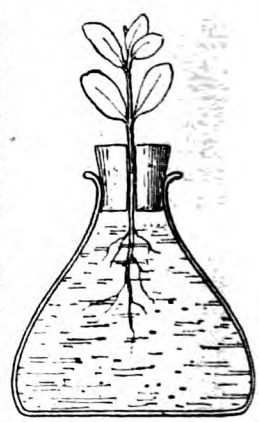
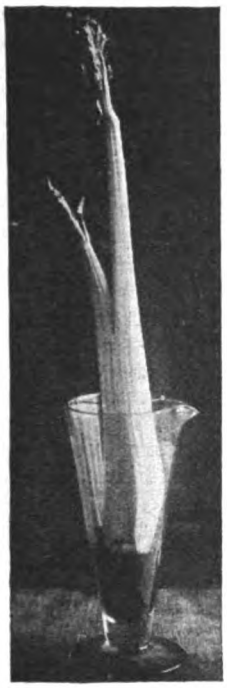
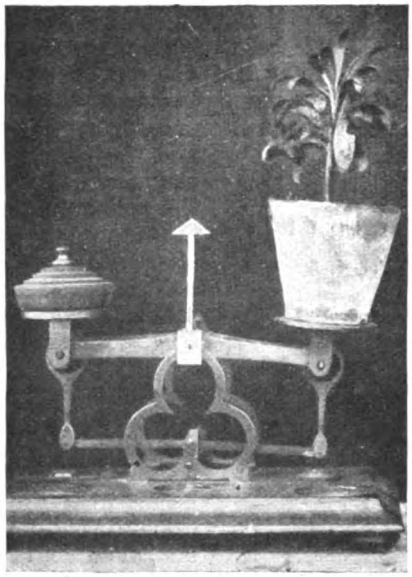
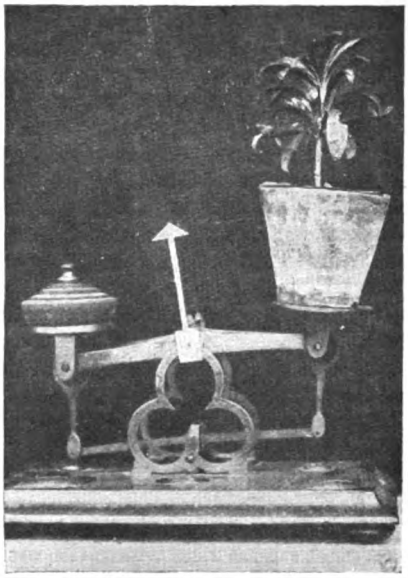


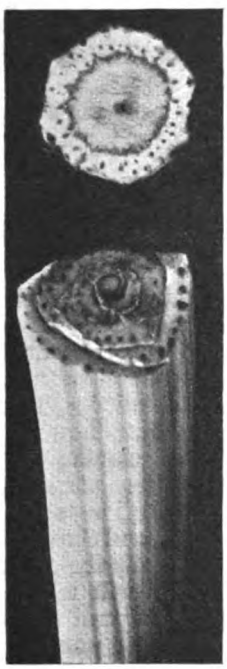
Fig. 37.—To determine the value of nitrogen to a plant.

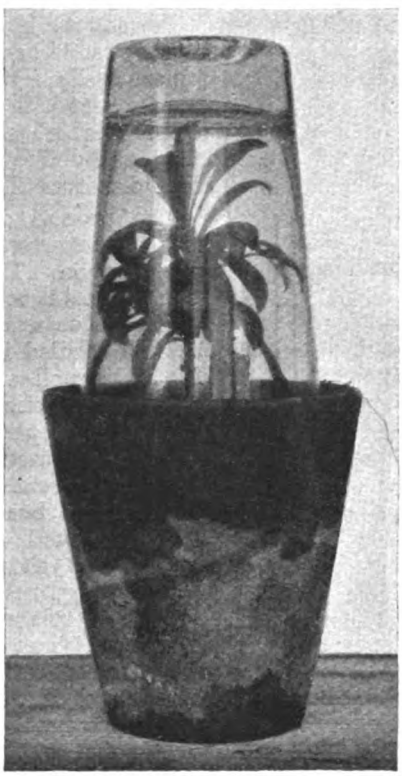
These necessary substances are not used in the same proportion by all plants. This is well known to the farmer, who always avoids growing the same crop on a field during two successive seasons. A cereal crop is followed by a root crop or by clover or beans, because they draw mainly on other constituents of the soil. The ash of clover, for example, has about 30–40 per cent. of lime, while wheat-ash only shows about four per cent. ; on the other hand, clover is much poorer in phosphoric acid than the cereals. This alternation is spoken

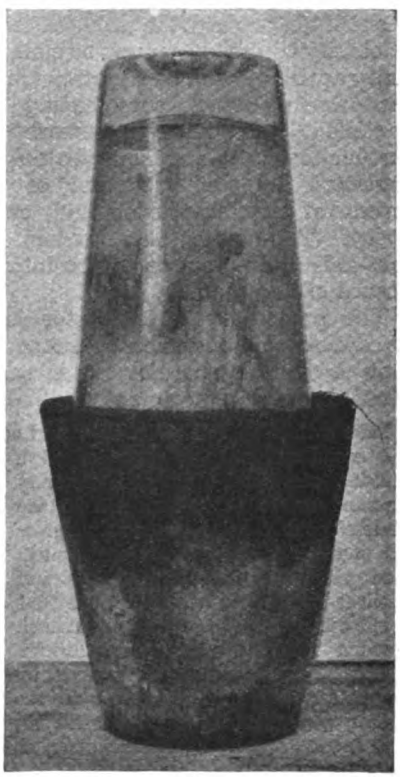












HOW PLANTS DRINK AND BREATHE.

1. The leaves of a stick of celery placed in a solution of red ink and water will turn pink. 2 and 3. Take a small pot plant and cover the soil with tin foil to prevent evaporation. Weigh the plant. Leave it in a sunny position; then weigh it again. It will be found to have lost weight, owing to transpiration of moisture through the leaves. 4. Section of the stick of celery (*vide* above), showing the water channels stained red. 5 and 6. Cover a plant with a glass and stand it in a sunny position; after a while the glass will become cloudy, thus showing that plants transmit moisture from their foliage.

of as the *rotation of crops*, and has been worked out entirely by experience.

The presence of worms in the soil should not be overlooked when we are considering the agencies at work there. Their burrowing in the earth improves the soil in three ways. First, by opening passages through it which aid its aeration; second, by moving the soil from below to the surface and generally helping to mix it; and third, by the chemical alteration made in the soil as it passes through their bodies. These processes are not, however, like those due to the bacteria, indispensable: they are valuable improvements only.

Fig. 38.—Showing how root hairs insinuate themselves among soil particles.

17. The Root and the Soil.—The most important parts of the root in its relation to the soil are the ends of the branches, where the root-hairs are. The root-hairs insinuate themselves among the soil-particles so closely that they cannot be shaken away again. The hair grows into the film of water surrounding the soil-particle; the water is absorbed, and a further supply comes from the neighbouring particles by the operation of the forces of surface-tension and capillarity. The water thus enters the root-hair and passes on to the interior tissues of the root.

The process by which water (with its dissolved substances) enters the root is called *osmosis*; it is easily illustrated by experiment.

Take a thistle-funnel (Fig. 39); and cover the broad end with a piece of pig's bladder, stretched tight and carefully gummed on to the glass. On to the bladder pour a little sugar solution or salt solution (about 25 per cent. salt); then place the funnel in a beaker of distilled water. It will be noticed that liquid will rise up the tube of the funnel, showing that water has passed through the bladder. It can also be proved, by evaporating some of the water in the beaker to dryness in a porcelain dish, that sugar (or salt) has passed from the tube into the water.

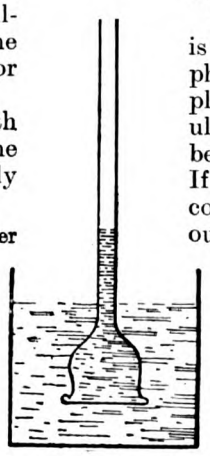


Fig. 39.—To illustrate osmosis.

The essential feature of this process of osmosis, it will be seen, is that, when two solutions of different strength are separated by the proper kind of permeable membrane, a mixing or diffusion takes place, in which the stronger solution becomes diluted and the diluted one strengthened. Further, a pressure is produced, called *osmotic pressure*, on the stronger side of the membrane.

Now these are the conditions that exist inside and outside the root of a plant. The wall of the root-hair is the permeable membrane; osmosis takes place across it, an exchange being made between the soil-water and the plant liquids. Equilibrium can never be established, because the soil-water is passed on as soon as it enters the root-hairs: it becomes altered in various ways—by metabolism particularly. Thus the conditions for osmosis always prevail, so long at least as the soil-water is a very dilute solution, which it usually is. Of the substances passed out of the root-hair during osmosis we know only one thing: they are usually acid. This fact is important, because certain plant-foods, such as calcium phosphate (bone-ash), will not dissolve in water unless it is acidified. Similarly, the acid enables the root to make its way through many soils, such as chalk, much more easily. If a growing seedling be left on a wet slab of marble, its roots act on the marble as they spread about, producing well-defined streaks, where the acid dissolves the marble.

The process of osmosis in plants is not, however, a merely physical phenomenon. The protoplasm in the plant guides it to some extent, particularly the outward process. This can be well studied in a slice of beetroot. If this is well washed and placed in cold water, none of the colour comes out; if it is placed in boiling water, the coloured sap readily comes out by osmosis, because the protoplasm has been killed. That water will come out, however, can be shown by placing any growing part of the plant in *strong* salt solution. The strong liquid is now outside, and the plant shrivels up owing to the withdrawal of water. It will recover if it is again placed in pure water.

The last point that we have to notice in this lesson is that growing roots are sensitive to the position of water in the soil. They always grow towards it, even when it is on one side and the effect of geotropism has to be overcome. Doubtless roots have acquired the downward and spreading habit, in part because that represents the best method of finding water. This movement of the root-branches towards water is often named hydrotropism.

E. W. E.

SOUND.—II

4. Velocity of Sound.—THE speed with which a longitudinal wave is transmitted through a homogeneous medium is given by the equation $v = \sqrt{\frac{E}{D}}$, where D = the density, and E the coefficient of elasticity of the medium. The coefficient of elasticity is the ratio of the distorting force to the distortion produced per unit volume.

If a volume V of gas at pressure P has its pressure increased by a small amount p, so that its volume is reduced by a corresponding small amount v, $E \div \frac{v}{V} = \frac{pV}{v}$.

By Boyle's Law, $(P + p)(V - v) = PV$.

$$\therefore PV + pV - Pv - pv = PV.$$

Hence, neglecting pv as the product of two small quantities,

$$Pv = pV$$

$$\text{or } P = \frac{pV}{v} = E.$$

Thus for a gas obeying Boyle's Law, the coefficient of elasticity is equal to the pressure of the gas.

If the velocity of sound be now worked out by substituting the observed values of the pressure and density of air in the equation $v = \sqrt{\frac{E}{D}}$, the velocity is given as 920 feet per second under standard conditions. The observed velocity is, however, 1,090 feet per second; and Sir Isaac Newton, who was the first to notice this discrepancy, was unable satisfactorily to account for it. The explanation was given by Laplace, who showed that Boyle's Law ought not to be assumed to be operative while longitudinal waves are passing. For Boyle's Law assumes that there is no change of temperature in the air, which is not true.

When a compression occurs in the air, heat is produced; and this heat has not time to dissipate itself through the surrounding air before the rarefaction comes. But the effect of the heat of compression will be to produce expansion, i.e. it aids the process of rarefaction which immediately follows the compression. Similarly the rarefaction itself, absorbing heat, cools the air, and hence aids the following compression. Thus in the parts of the air subject to the wave, the conditions are not *isothermal* (of constant temperature) as required by Boyle's Law. Changes of temperature occur both at compression and rarefaction which quicken the velocity of the wave. The conditions are those known as *adiabatic*, in which there is no heat gained or lost to the air as a whole. In our formula we must therefore use the adiabatic coefficient of elasticity instead of the isothermal coefficient. The ratio of these two coefficients is known from other considerations to be 1·4 very approximately. Introducing this factor, we have $v = \sqrt{\frac{E \times 1{\cdot}4}{D}}$ = 1,090 feet per second, very nearly.

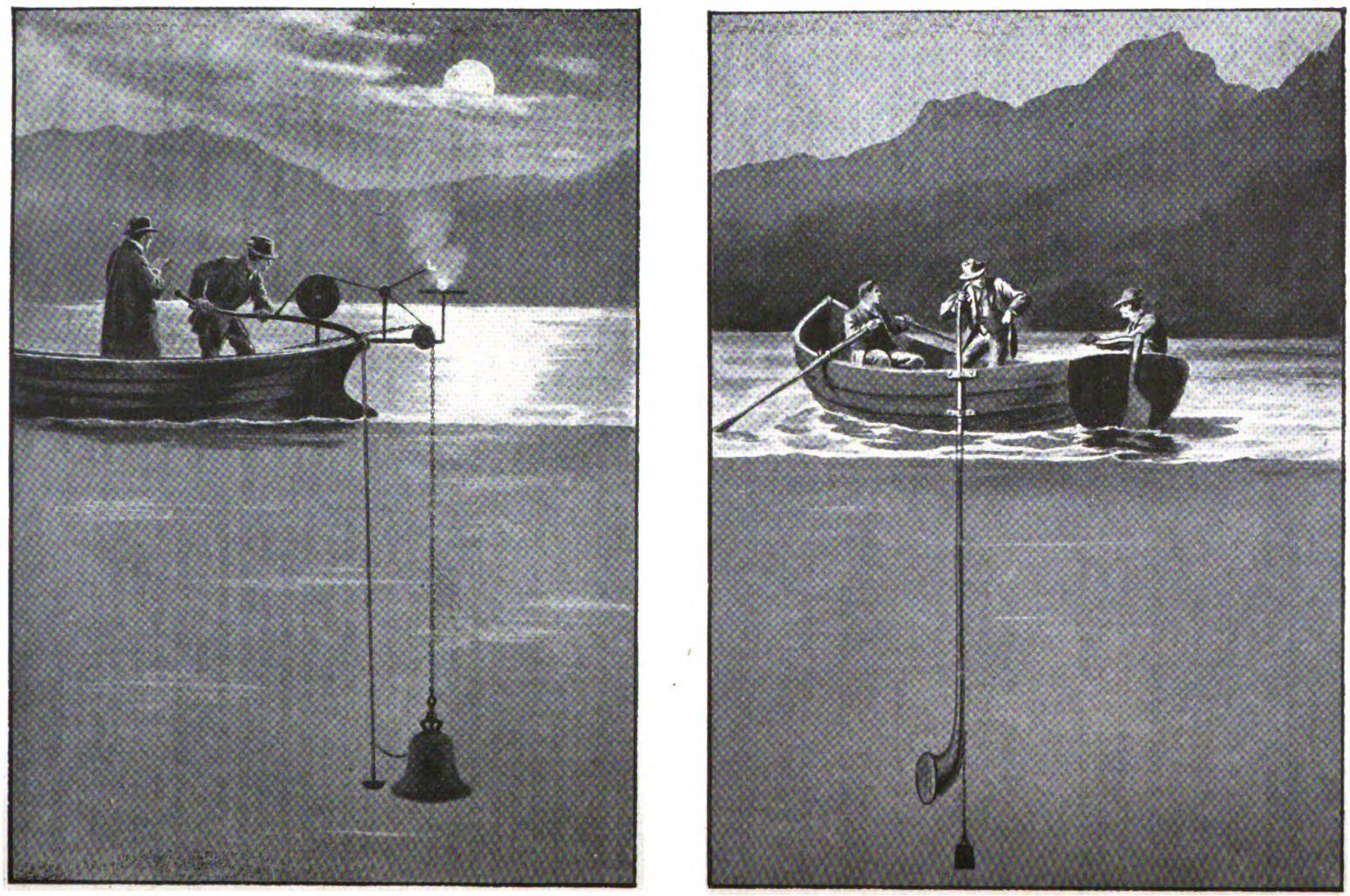
The density, D, in this formula is of course the mass of unit volume of the substance at 0°. If the substance is heated to $t°$, unit volume expands to $(1 + \alpha t)$, where α = the coefficient of expansion, and the mass of unit volume at $t°$ becomes $\frac{D}{1 + \alpha t}$. Hence the velocity of sound at $t°$ = $\sqrt{\frac{E \times 1{\cdot}4}{D}(1 + \alpha t)} = 1{,}090\sqrt{1 + \alpha t}$ feet per second. If t is 1°, this works out to nearly 1,092 feet per second; and the velocity of sound is observed to increase at about the rate of two feet per second per degree C.

The experimental determination of the velocity of sound in air is simple in principle, but requires care in its execution. Several sources of error are liable to enter. Two observers, A and B, stand at a considerable distance apart; A fires a cannon, and B records the interval between his seeing the flash and hearing the sound. As the time taken by the flash is negligible, the interval gives the time taken by the sound to travel the measured distance. Allowance must be made for the temperature and for the humidity of the air, and these are not necessarily uniform over the whole distance, even when the most favourable day is chosen. The velocity of the wind must also be found and allowed for. If this blows direct from A to B, it can be eliminated by the method of reciprocal firing: both observers have a gun, and make observations alternately; since the wind aids the sound in one direction as much as it retards it in the other, the average of the pairs of reciprocal observations eliminates the effect of it.

The result is still further vitiated by the personal equation of the observer. A small but quite distinct interval elapses between the perception of a sight or sound, and the record of it. This interval is not the same for visual and for audible perceptions, and it is not even constant for the same observer. Regnault sought to evade the difficulty by devising apparatus for recording electrically both the time of firing and the time of receiving the sound. But mechanism has a personal equation also; and the best method of avoiding it is probably that adopted by Stone in his Cape Town experiments in 1871.

The distance between the two observers was about 15,000 feet. Suppose the velocity obtained, after eliminating all sources of error except personal equation, to be v. Let x = the small error of time due to the personal equation. Now suppose a second observation was made over a short distance, say 1,500 feet. The time taken for sound to perform this distance is very approximately $\frac{1{,}500}{v}$. If it was observed to be t, we then have $x = t - \frac{1{,}500}{v}$ very approximately. The personal equation has the same numerical value as in the larger experiment, if the intensity and pitch of the sound are suitably adjusted; but its effect on the time observed is not proportionally so great when t is large: x is a smaller percentage of $10t$ than of t.

Indirect methods of determining the velocity of sound in air will be studied later; we may here note that the velocity in hydrogen is four times as great



THE VELOCITY OF SOUND IN LIQUIDS

was first measured directly in Lake Geneva in 1826. A bell was struck a few feet below the surface and a charge of gunpowder fired at the same instant. The flash was observed and the sound received by a distant observer by means of a large ear-trumpet. The velocity of sound in water is 1,445 metres per second; in air, 332 metres (1,090 ft.) per second.

as that in oxygen, whose density is sixteen times as great. This is what we should expect from the formula $v = \sqrt{\frac{E}{D}}$.

The velocity of sound in liquids can be calculated from the same formula; it was first measured directly in Lake Geneva in 1826. A bell was struck a few feet below the surface, and a charge of gunpowder was fired at the same instant; the flash was observed, and the sound received by a distant observer. The receiver was a kind of enlarged ear-trumpet, with the open end in the water (*see* opposite).

In solids we generally have recourse to indirect methods; but by choosing a suitable coefficient of elasticity, the formula may be applied. The velocity of sound in solids is greater than in liquids or gases, in spite of their greater density; as they offer great resistance to elastic distortion, their coefficient of elasticity is very large.

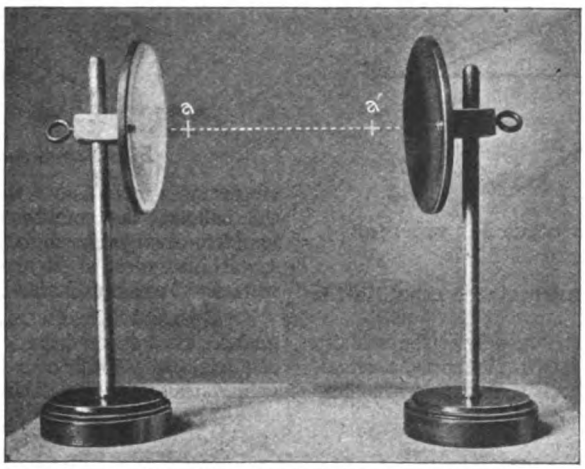


Fig. 9A.—To show that Sound conforms to the same laws of reflection as Light.

A few typical results are appended:—

Substance.	*Velocity of Sound at 0°.*
Air	332 metres per sec. (1,090 feet).
Hydrogen ..	1,270 ,, ,, ,,
Oxygen ..	318 ,, ,, ,,
Water ..	1,445 ,, ,, ,,
Glass ..	5,500 ,, ,, ,,
Iron	5,000 ,, ,, ,,

5. Reflexion of Sound.—Like other waves, those of sound are either wholly or in part reflected when they impinge on a fresh medium. This reflexion obeys the same laws as that of light; the angle of incidence is equal to the angle of reflexion. If two concave mirrors are placed, say, 30 feet apart, exactly facing each other, and a bright light be placed at the point marked W (Fig. 10), which is the focus of the left-hand mirror, its rays will be reflected on the other mirror and concentrated at the point F. Similarly, if a watch is placed on the axis of a concave mirror, a distinct sound-image is formed at the position, calculated as in Light from the principle of conjugate foci. The sound may be collected by means of a small funnel connected with the ear by rubber-tubing, or may be rendered visible by means of a sensitive flame. This latter is obtained by connecting a tube, drawn out to a very narrow nozzle, with a supply of gas at a high pressure which can be regulated. When the gas is lit, the flame can be made to "roar" by suitably arranging the pressure. The flame is sensitive when it is just on the point of roaring; in this state it is elongated and burns steadily; but if a sound be focused on it—even if we merely sing or talk in its neighbourhood—the flame shortens and broadens, and roars. This happens at the position calculated from the optical formula

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}.$$

The experiment is most effectively done by arranging two mirrors with their axes coincident (Fig. 9A). The watch is placed at the principal focus a of one of the mirrors, and the sound is found to be focused at the principal focus a' of the other. If the funnel is used, note that its mouth must face the second mirror.

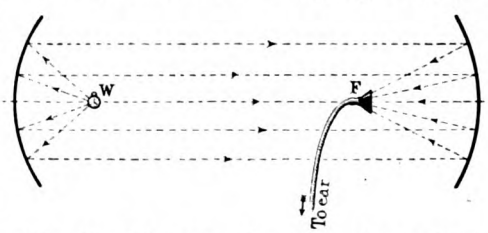


Fig. 10.—Diagrammatic explanation of the reflection of Sound.

In common life, echoes give us the most familiar example of the reflexion of sound. If a sharp clap be made in front of a high wall, the reflected sound is heard at an interval easily calculable from the velocity of sound and the distance of the wall. If the wall were, for instance, 110 feet away, the interval would be $\frac{1}{5}$ second, since the sound has to travel 220 feet before reaching us a second time. Echoes are not always heard, however, when we might expect them: partly because only a small portion of the returning wave reaches the ear, partly owing to interference between the direct and reflected waves. An enclosed valley or a curved cliff give the most effective results. The well-known whispering gallery of St. Paul's Cathedral is an instance of reflexion taking place under conditions preventing excessive diffusion of the sound; if the dome were removed these conditions would not prevail, and the whisper could not be heard at all points of the wall.

Reflexion of sound can also take place from layers of air of differing density. A layer of heated air will often make sounds on the other side of it indistinct, or even cut them off altogether. On a night apparently quite clear, sounds are not clear,

nor are they conveyed very far, whereas on a foggy or misty evening sounds can often be heard at a great distance. In the latter case the air is probably more uniform in density, and not disturbed by the warm ascending currents that act as partial reflectors in the former case.

The use of the stethoscope and the ear-trumpet

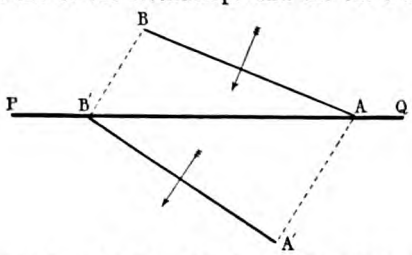


Fig. 11.—To show that Sound is refracted in the same way as Light.

also depends on the reflexion of the sound in the tube.

6. Refraction of Sound.—Since the velocity of sound is not the same in all substances, a sound-wave will be refracted when it strikes a new medium obliquely, in a similar manner to light-waves. Suppose P Q to be the bounding surface between two media, say air and water. Let A B represent a portion of a wave-front advancing towards P Q perpendicularly to itself. When A strikes the surface P Q, it begins to move at a new velocity. Suppose it advances to A′ in the time taken for B to reach P Q at B′. The wave-front is now in the direction A′ B′, which is clearly different from A B, because A A′ is not equal to B B′ (Fig. 11).

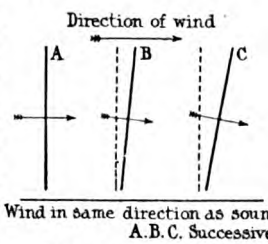


Fig. 12.—How refraction is induced by wind.

This kind of refraction is also induced by wind. If the sound is moving in the direction of the wind,

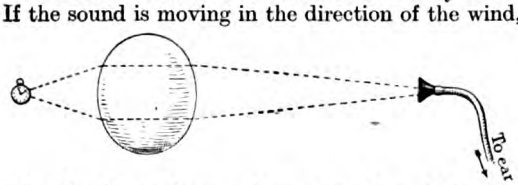


Fig. 13.—Sound lenses: how to make and demonstrate their use.

which has a greater velocity in the free air than near the ground, the upper parts of the wave get in advance of the lower parts, and the wave-front tends to turn towards the ground. When the wind is against the sound, the opposite effect is produced, and the sound is directed upward. Thus sounds will be heard better when they come with the wind than against it (Fig. 12).

Refraction also takes place when sound passes into a stratum of air of different density; this is one reason why sounds are not heard clearly in air that is not uniform.

A converging lens, able to act towards sound-waves as a convex lens does towards light, can be made by blowing up a thin rubber balloon with carbon dioxide. A watch is placed on one side of the balloon, and at one place on the other side a spot can be found, either with an ear-trumpet or with a sensitive flame, to which the sound con-

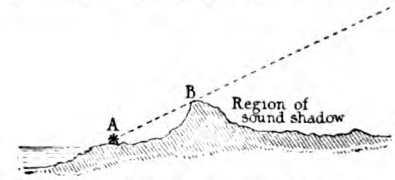


Fig. 14.—Sound shadows.

verges after refraction. If hydrogen is used to fill the balloon, the sound-lens thus formed will be found to diverge the sound, because the velocity of sound in hydrogen is greater than it is in air, whereas in carbon dioxide it is less (Fig. 13).

7. Sound Shadows.—It will have been noticed that water-waves, when they approach an obstacle, often break over it and disturb the water behind the obstacle. This occurs especially when the obstacle is not considerably larger than the waves. When the obstacle is large a definite area of shadow can be observed, but it has no clean geometric boundary like an optical shadow; a great deal of water splashes round the edges, and even the waves enter the shadow area. Very similar phenomena are noticed in the case of sound. Sound can be heard round corners, showing that the waves do get round into the shadow to some extent; but if we listen to the passage of a railway-train through an embankment, we can convince ourselves that there is a very considerable loss of intensity when the bank is between us and the sound. Complete sound-shadows are uncommon; in his experiments with fog-signals on Dover cliffs, Prof. Tyndall found a good one. A fog-signal at A, which could be heard well out at sea, could not be heard at a tenth of the distance in the sound-shadow cast by the tall cliff, B (Fig. 14).

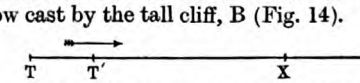


Fig. 15.—Illustrating Doppler's Principle.

8. Doppler's Principle.—When a sounding body is moving rapidly towards us, it is noticed that the pitch of the note perceptibly rises, and, conversely, that it falls when the sound is receding. This can be explained in the following way, on what is known as Doppler's principle.

Suppose a train moving at the rate of 60 feet per second is advancing towards us giving out a note of pitch 500. Taking the velocity of sound as 1,100 feet per second, the wave-length of the note will be 1,100 ÷ 500 = 2·2 feet, if the train is at rest.

Let T be the position of the train at a given instant. After one second it has moved to T′ where T T′ = 60 feet, and meanwhile the sound-wave starting from T has reached X where T X = 1,100 feet. In this second the source of sound has given out 500 waves, and these are all included in the space T′X = 1,040 feet. Hence, the wave-length has become $\frac{1,040}{500} = 2{\cdot}08$ feet. Hence, the frequency of the note perceived at X will be $\frac{1,100}{2{\cdot}08} = 529$. The velocity of sound itself does not change, and the change of pitch results from a change of wave-length (Fig 15).

We do not obtain quite the same result if the observer approaches the sound. For suppose X to be now the sounding-body at rest, and T the observer advancing towards X at 60 feet per second. When the observer has reached T′, he has received not only the 500 waves that he would have received at T, but also those included in the distance T T′, i.e. $\frac{60}{1,100} \times 500 = 27$. Hence, the frequency of the sound heard by him will be 500 + 27 = 527.

E. W. E.

ZOOLOGY.—XXI

THE order *Selachii* includes the Sharks and Rays, sometimes known as the Cartilaginous Fishes, from the fact that the skeleton consists rather of cartilage than of bones. Of this order the sub-order *Squali*, which includes the Sharks and Dog-Fish, is rightly regarded with detestation. The coupling of the dog-fish with the shark is entirely natural since to all intents and purposes the lesser evil is no more than a reduced model of the greater. But whilst the majority of the sharks are viviparous, the true dog-fish is oviparous, the eggs being enclosed singly in horny cases termed "purses."

Sharks—

The White Shark is familiar to everyone either by sight or by repute. With a length of from twenty to thirty-five feet, or even more, it haunts the warm waters of the tropics, where, cursed with an insatiable appetite, it refuses nothing that comes in its way. Both the mouth and the throat are of wide dimensions, while the saw-shaped teeth are exceedingly numerous and powerful.

The Common Blue Shark is a smaller fish, though specimens attaining a length of fifteen feet have been taken in the deep seas. Individuals which visit our western coasts during the summer seldom exceed eight feet in length. Though willing to eat man, the Blue Shark is satisfied to live upon small fish, amongst which he does great execution, following the shoals at times even into the fisherman's net.

Writing of these monsters an authoritative writer remarks: "The muscular vitality of these fishes is as remarkable as that of reptiles and amphibians, for in one recorded instance, after a shark had been caught and the body severed from the head and thrown overboard, it continued swimming about for hours."

Whether this story can be corroborated or similar instances given, I do not know.

Genera allied to the *Carcharias* include many species which differ from each other in such characteristics as teeth, lips and tail, amongst them being the Black Finned Shark.

The Great Blue Shark, the most formidable of his tribe, is known to grow to thirty feet in length.

Some extinct species of *Carcharodon* must, however, have exceeded this length. Indeed there are, or were, jaws in the British Museum obtained from Australian specimens which Dr. Günther states to have been thirty-six feet and a half long.

—their Ferocity and Habits

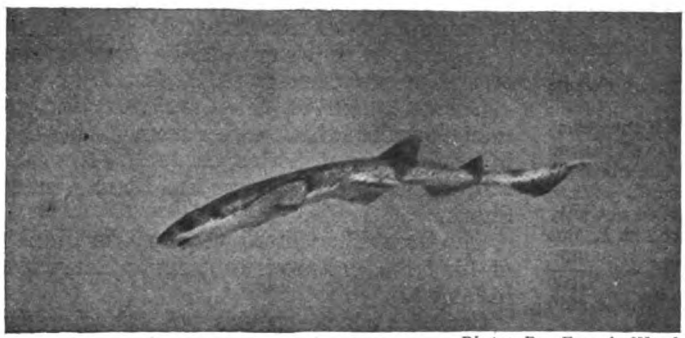
The Hammer-Headed Shark is distinguished by the peculiar formation of the head, which resembles the letter "T." The eyes are placed at the ends of the projecting extremities. These sharks are found in most temperate and tropical seas, and have been met with, though fortunately but rarely, off the British coast. The Hammer-Head attains a length of about fifteen feet and bears an unenviable though well-deserved reputation for ferocity.

The Basking Shark, a huge fish some thirty-six feet or so in length, is common in northern waters, and may be met with at times off Donegal and the western coast of Scotland. His body is productive of a certain amount of oil, and when attacked for this or any other reason he can prove a dangerous antagonist, since a blow from his tail will stave in a small boat; otherwise this great fish must be numbered amongst the most innocent members of a disreputable family.

The Whale Shark as his name implies is the largest of living sharks, attaining a length of from fifty to sixty feet. It is met with most frequently though not invariably in the Indian and Pacific Oceans: it has been found elsewhere.

The Thresher or Fox Shark is found chiefly in the Atlantic and Mediterranean, though it sometimes makes its way into the English Channel and the North Sea. In

this fish the upper lobe of the tail is developed to an extreme length ; in fact of the length of fifteen feet to which the Thresher commonly attains the tail accounts for half. The Thresher does great execution amongst herrings, pilchards and sprats, and it is



DOG-FISH. *Photo: Dr. Francis Ward, F.Z.S., F.R.P.S.*

A shark-like creature which frequents British waters.

recorded by the late Mr. Frank T. Bullen and others who claim to have witnessed such contests that it does not hesitate to attack the gigantic Right Whale.

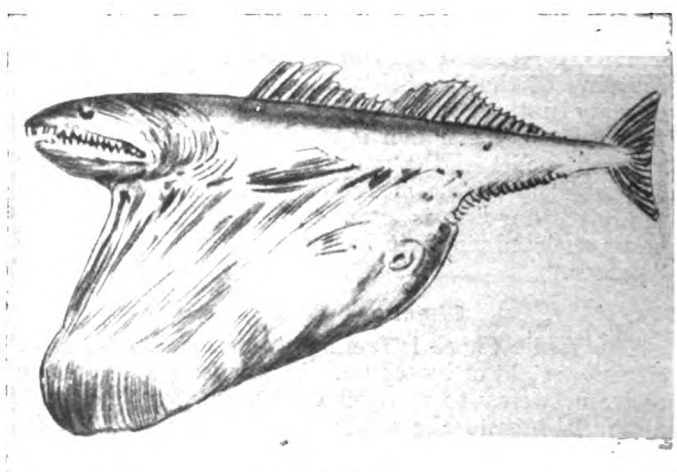
Mr. Bullen thus describes such an encounter in " Creatures of the Sea." " The shark appears to balance himself upon his head in the water with the whole of his enormous flail-like flukes in the air at the moment of striking ; then, when the blow has been delivered, there is a quick descent and return, like the lashing of a gigantic whip, while the blows are audible for two miles on a calm day. So heavy are they that strips of blubber are cut by them from the back of the hapless whale, four to six inches wide and two to five feet in length."

The Smooth Hound, which attains an extreme length of about three feet, is frequently taken in British waters. The tail is short and its hinder margin usually whitish ; the colour of the body is a uniform grey, with small whitish spots above the lateral line. Other shark-like fish which frequent British waters include the Smaller Spotted Dog-Fish, the Larger Spotted Dog-Fish or Nurse Hound and the Piked Dog-Fish. The Spotted Dog-Fish live mostly upon crustaceans and molluscs. The larger species attain a length of about three feet.

The curious Angel-Fish or Monk-Fish which is included in the *Selachii* on account of its internal structure more greatly resembles in outward appearance the Rays, since the head and body are broad and flat. The Angel-Fish attains a length of five feet, and is to be found throughout the tropical and temperate seas.

The Saw-Fish, Skates and Rays, which together constitute the sub-order *Raii*, differ considerably from each other in some important respects. The *Pristidæ* or Saw-Fish are characterised by the extraordinary development of the upper jaw, which projects occasionally to a length of six feet, in the form of a saw. It is upon this weapon that the Saw-Fish depends for its food, its teeth being used to tear flesh from carcases which the saw has already provided. The *Pristes Antiquorum*, a species found in the Atlantic and Mediterranean, attains a length of eighteen feet, and species six feet or so longer are common in Asiatic waters.

The family *Raiidæ*, or Skates and Rays,

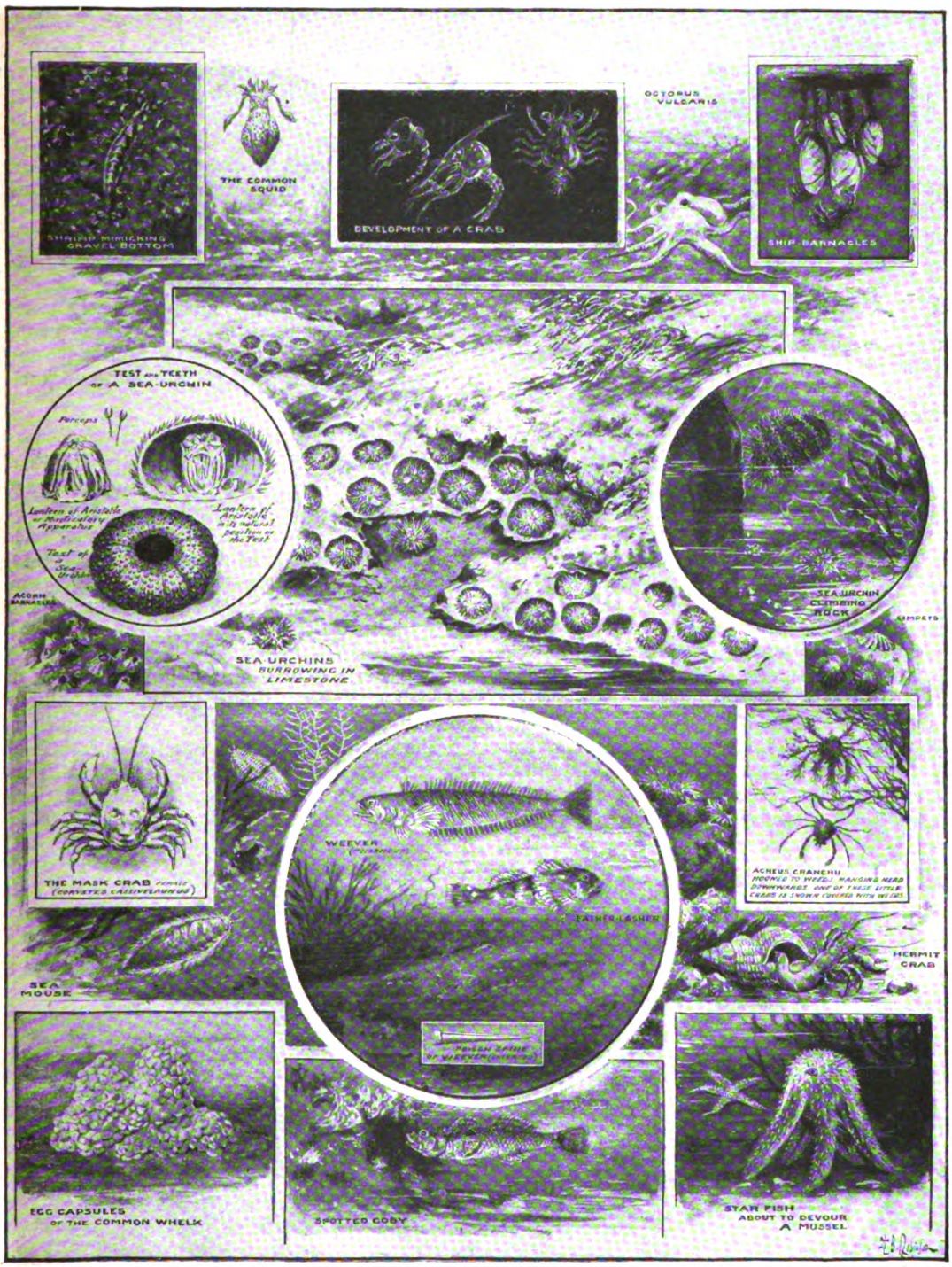


A DEEP-SEA FISH.

Note the abnormal size of the air bladder.

are far less formidable. The flattened body of the true Ray is well adapted to life on the sea bottom, where this fish passes a sluggish existence subsisting on molluscs, crustaceans and small fishes. The Common Skate, which is common off our coasts, is one of several species constituting the *Raia*, all of which are marketable.

As a rule the Rays are to be found close to shore, the almost solitary exceptions



Drawn by W. B. Robinson.

DENIZENS OF THE SEA SHORE.

These illustrations will enable the reader to identify many of the mysterious, though familiar, creatures that are to be found in rock pools and along the sea shore.

being the Eagle Ray. The largest of the Rays, the so-called Devil-Fish, a member of the same family as the Eagle Ray, has been known to measure fifteen feet across, and to weigh over 1,000 pounds.

The Electric Rays are found principally in the Mediterranean Sea and the Indian and Atlantic Oceans, though they are occasionally caught in British waters. In this species the tail can be made to discharge electric shocks of considerable power.

Sting Rays

Dr. Ridewood of the British Museum (Natural History) remarks that this discharge in the case of a fish three feet in breadth is sufficiently powerful to disable a man. The Sting Rays are mainly inhabitants of tropical waters. They gain their name from the long whip-like spine, which takes the place of the dorsal fin, with which they administer a painful wound.

The Chimæroid Fishes form a sub-class occurring] mostly in deep water. The Northern Chimæra encountered in the Mediterranean and the Atlantic has gained the title " Rabbit-Fish " from the peculiar shape of its head.

Another sub-class of unusual interest are the Lung-Fishes of Africa and America. These fish are wonderfully fitted to survive in territories in which more or less prolonged drought is not infrequent since the air-bladder which in normal cases, as has been explained, is used as a gas bag for increasing or decreasing the weight of its owner, is here adapted for service as a lung. The Lung-Fish in fact can breathe through his gills in the water, and can breath by his air-bladder when water is no longer to be found. The Gambian Lung-Fish and similar species in Africa and America remain for long periods buried in the mud breathing through an air hole. When rain once again fills the rivers and the mud liquefies, they recommence to use their gills.

Of living representatives of the order *Astylopterygii* or Ganoid Fishes, the best known is probably the Sturgeon. In this fish scales are largely missing, their place being taken to some extent by bony scuta or bucklers. The snout is pointed, and both jaws are formed of two bone-covered cartilages.

Species of Sturgeon

The Common Sturgeon, known in England as the " Regal Sturgeon," is found off most of the coast lines of Europe and of North America. In common with other species it forms the source of caviare and isinglass, the latter being prepared from the air-bladder. The Great Russian Sturgeon, which is taken in the rivers flowing into the Black Sea and the Caspian, is a larger fish than the Common Sturgeon, reaching a length of twenty-five feet. The Sterlet is highly valued as an article of diet. It is abundant in the Caspian, where it attains a length of between two and three feet. The Gar-Pikes and the Bow Fins of North America, are also included in the *Astylopterygii*. A. B.

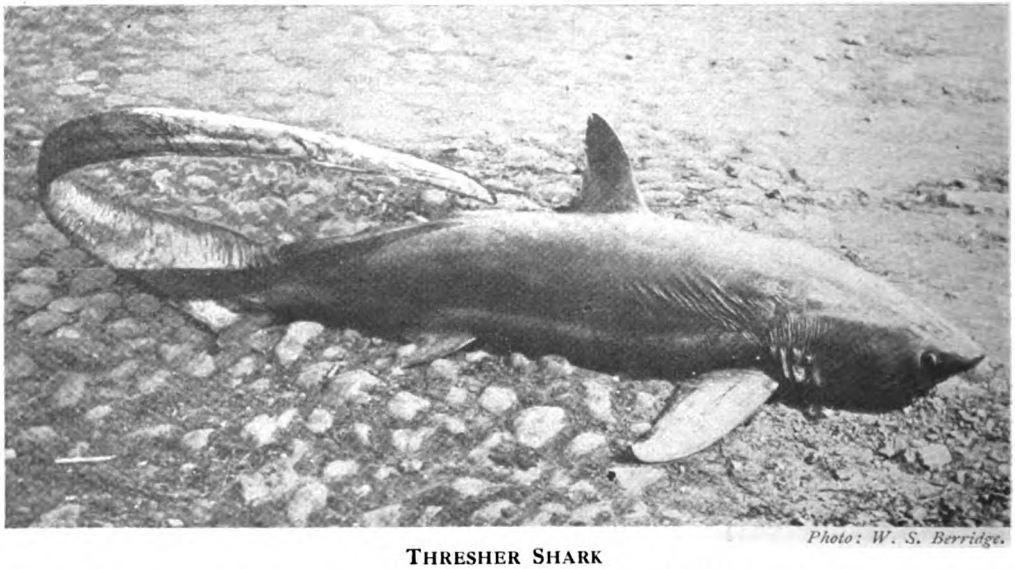


Photo: W. S. Berridge.

THRESHER SHARK

sometimes makes its way into the English Channel and North Sea, though is usually found in the Atlantic and Mediterranean.

ANATOMY AND PHYSIOLOGY.—II

HUMAN anatomy is the study of the structure of the human body. Anatomy means "cutting up," and it includes all that can be learnt about a body by dissection—that is, by cutting away the skin and separating and examining all the parts underneath.

When you examine a body, you see at once that it consists of a trunk, a head, and four limbs. When you dissect it you find that the trunk is hollow and consists of two cavities, called the chest and the belly. These cavities contain "organs," such as the heart, lungs and liver, which are all so shaped that they fit one against the other; if one has a bulge the one next it has a hollow to fit this bulge.

The whole body, trunk and limbs, has a hard bony framework, the skeleton. The bones are covered with flesh or muscle, and through the flesh run fine tubes which contain blood. As well as these tubes or "blood vessels" there are cords running through the flesh, and if these are dissected they can all be traced back to the spine, or backbone; these cords are nerves.

What Anatomy Teaches

This is the kind of thing one learns in studying anatomy. There are so many bones, of such and such a shape; there are muscles which are attached to these bones; the muscles are supplied by particular nerves. The organs of the body have their own special shapes and positions.

These things would be very difficult to remember by themselves: the importance and interest of the whole study lies in the *functions* of the organs and parts.

The functions of the body are studied in physiology. In this we learn what the heart does, what use it is to the body, what the lungs are for and how they work, why we have muscles and nerves and bones and how they are used.

We cannot learn anatomy with any interest without physiology.

In a similar way we cannot learn physiology without anatomy. We all know that we breathe, that our hearts beat, that we see and hear, and if we want to know how these things are done, and what is their importance to us, we have to know what the organs are which do these things for us and how they work. Anatomy and physiology, therefore, have to be learnt together.

It may be asked why the two subjects which are so closely united should ever have been separated. It comes about in this way. The people most concerned with anatomy and physiology are doctors, and their course of training is arranged in a particular way for the following reasons.

In the study of physiology, one of the things we have to learn about is food, meat, and bread, and fat, and so on. Only some parts of the food are really nutritious, and we have to find out what those parts are and what becomes of them after they have been eaten. Therefore it is necessary to be able to analyse the food and find out exactly of what it consists. For this a knowledge of *chemistry* is required. All through physiology questions of chemistry keep cropping up.

Again, the heart works like a pump, and when the limbs are moved one bone acts as a lever on another bone, so it is necessary to know something about pumps and levers. These things are learnt in the study of physics.

Physiology and Biology

Physiology is really the study of the chemistry and physics of the body. A doctor's scientific training, therefore, begins with the study of chemistry and physics, and since he is going to deal with the chemistry and physics of human beings, the most complex of all animals, he goes on from those subjects to the study of the simplest forms of animal and plant life.

This is called "biology," and means the study of life. He learns about the structure and function of these simple animals before beginning to work on human anatomy and physiology.

Human anatomy and physiology, therefore, together make up the study of human biology, or the study of human life. Each of these subjects is so large that it makes a lifelong study for people who specialise in it, so that students attend classes in physiology under one set of teachers and classes in anatomy under another set. The two subjects are, however, taught at the same time, and examinations in both always have to be passed together.

In this series of lessons, therefore, we are studying the elements of human biology—that is, the *structure* of the human body, under the name of anatomy, and its *functions*, what the body does and how it does it, under the name of physiology.

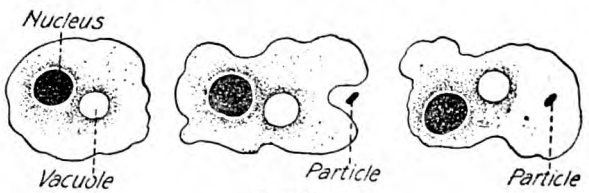
Since chemistry and biology enter so much into anatomy and physiology, a few words are required about each subject.

Chemistry is the study of the composition

of materials. Anything in the world—coal-gas, sea-water, diamonds, or what you please—can be analysed by chemistry, and everything contained in it can be found out. If you made an analysis of a specimen of sea-water you would find that it consisted of water, in which was dissolved some "common salt," the same as ordinary table salt, and other things in smaller quantity. You could take the water, freed from everything else, and analyse that, and you could "break it up" into two gases, called "oxygen" and "hydrogen," and you would find that there was twice as much hydrogen as oxygen.

In the same way you could take the salt, and you could "break" that up into a solid metal called "sodium" and a gas called "chlorine."

These four things, oxygen, hydrogen, sodium and chlorine, are called "elements," and no matter what you did to them you could not break them up any farther. Water is a combination of hydrogen and oxygen, common salt is a combination of sodium and chlorine, but each of these things by itself is an element and cannot be further analysed.



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Chemists analyse all substances and find of what elements they consist. Besides finding out what are the elements in any substance, chemists have to find out in how many different ways they can be combined. For instance, we have seen that hydrogen combines with oxygen to form water, and sodium combines with chlorine to form common salt. Hydrogen will combine with chlorine to form hydrochloric acid.

The simple chemical tests used in analysis are employed in this way. Nitric acid is a combination of three gases, hydrogen and nitrogen and oxygen, and silver can be dissolved in it, the silver combines with the oxygen and nitrogen, and a compound called silver nitrate is produced, which can be dissolved in water and forms a clear solution. If some hydrochloric acid is poured into a solution of silver nitrate, the liquid becomes cloudy, a white "precipitate" is produced which consists of silver chloride, a combination of silver and chlorine. This occurs for two reasons: (1) The silver has a greater "affinity" for chlorine than for nitric acid, so that it joins on to the chlorine and leaves the nitric acid; and (2) the substance silver chloride so formed will not dissolve in water and so can be seen as a mass of solid particles in the cloud which appears when the hydrochloric acid is poured into the silver nitrate.

Chemists have worked out tables based on facts of this kind which have been found by experiment, so that tests can be made for the presence of different elements according to what liquids they will dissolve in, and what solutions will "precipitate" them.

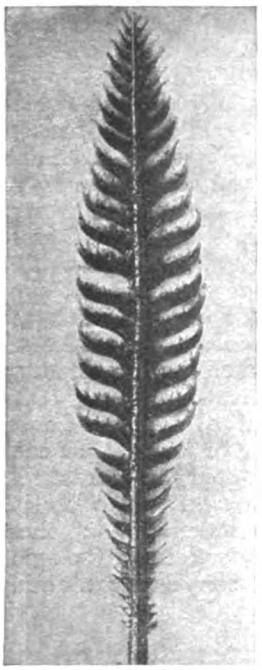
Methods of this kind have to be used to find out the materials of which the human body is composed, the composition of food, the changes it undergoes in the body, and the state in which it is got rid of from the body.

In biology we learn some things which are true of all living animals, and which can be easily seen and followed in simple forms of life, after which the same knowledge can be applied to the organs of human beings.

There is a small animal which lives in water and is called an *amœba*. It can only be observed with a microscope. When this animal is resting it appears as a little round ball of jelly. Inside the jelly is a round mass which is different in structure from the jelly in which it lies. The jelly is called "protoplasm" and the mass in the middle of it is called the "nucleus."

All living things contain protoplasm: it is the substance which can do the things on which life depends. Let us see what those things are.

If you put your amœba in warm salt and water and watch it under the microscope, you will find that it moves. That is the first characteristic of an animal that you will notice. It moves by thrusting out a portion of its jelly, and then drawing the rest of its body after this thrust-out part. If in its course it meets a particle of food, it will thrust out a process of jelly on each side of this particle and take it into itself. The particle of food will disappear, it will be dissolved, and if any part of it cannot be dissolved it will be thrust out, much as it was taken in. The amœba has digested part of it and got rid of the useless part. This is how the amœba gets nourished and gets rid of waste material, things which all living animals have to do.



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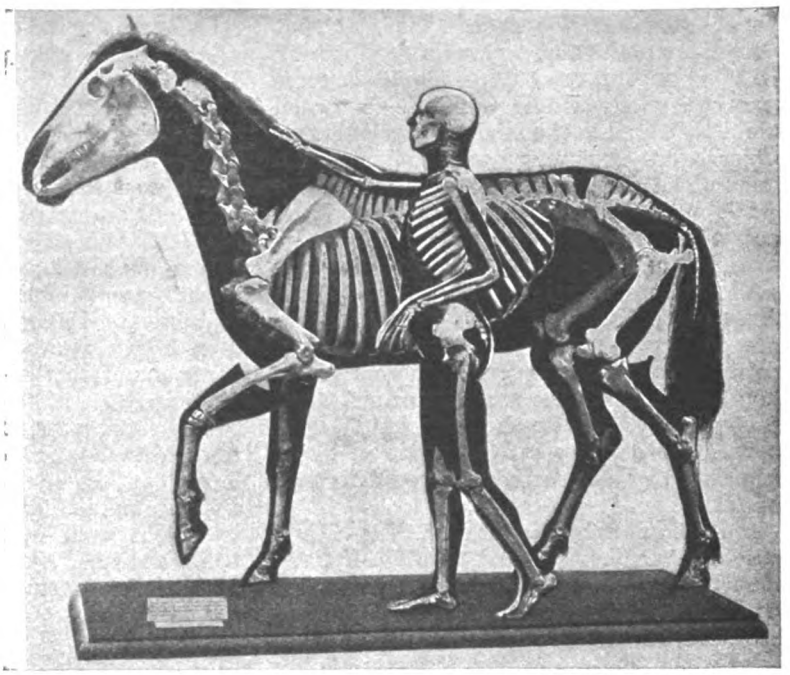

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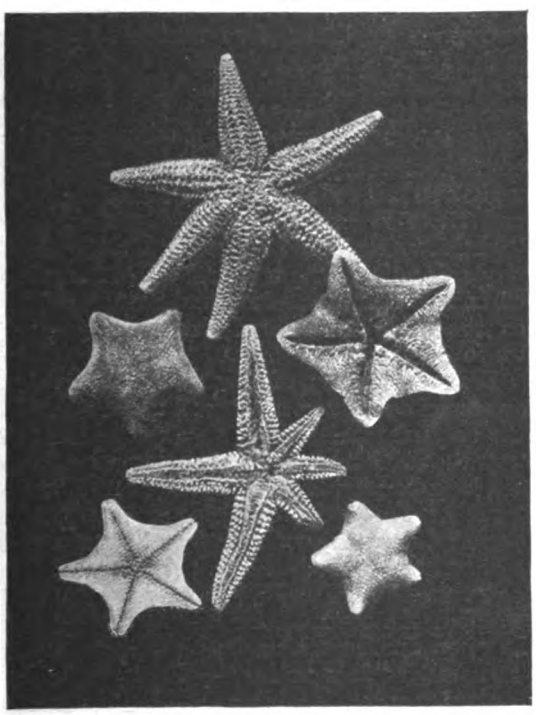

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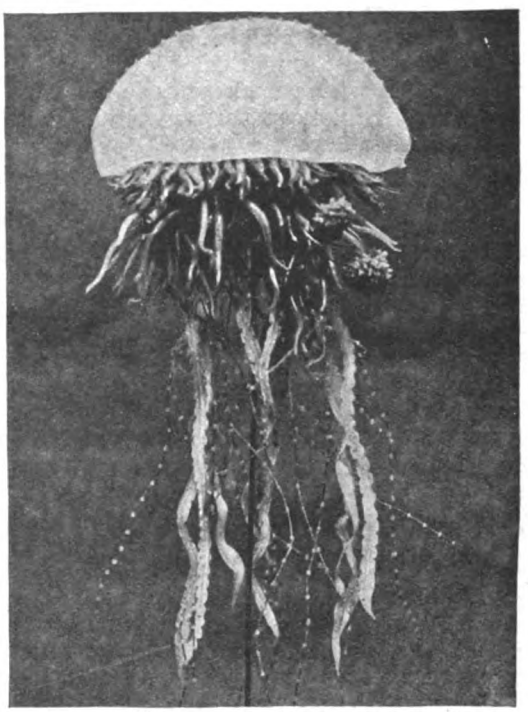


4

Photos: 1 and 4, Ullyet; 3, F. Martin Duncan.

VERTEBRATE AND INVERTEBRATE.

1. Invertebrate: the sea fern, a colony of living creatures. 2. Vertebrate: comparative studies of man and horse. 3 and 4. Invertebrate; a group of star fish and a Portuguese man-of-war.

There is one very important point which cannot be noted too soon. We saw that when the amœba met a piece of food it took the food into itself. Why should it have done so ? Why should it not have turned aside ? It took in the food because all living things adapt themselves to what is around them. The food was in its neighbourhood, and it made the necessary movements and took the food in, it adapted itself to its surroundings.

All living things, indeed, adapt themselves to their surroundings, they only are able to live by constantly doing this, and when they can no longer adapt themselves they die. This is the most important thing in physiology, and we shall constantly refer to it. Life depends on the power of living animals to adapt themselves to their surroundings.

A dead animal, or a lifeless thing like a table or chair, cannot adapt itself. If there is anything near to injure it, it cannot get out of the way, it cannot feed itself, it can do nothing to repair itself if it gets broken. This is the great contrast between living and dead things.

To return to the amœba. We have seen that it is a very simple thing, just a little lump of jelly with a nucleus inside it. And this simple animal can move and take food and get rid of waste.

From Amœba to Man

An amœba is said to " consist of a single cell." A " cell " in physiology means a little mass of protoplasm containing a nucleus. All animal bodies are made up of cells. Skin consists of cells, muscles consist of cells ; all the organs consist of cells.

The amœba cell, as we saw, does a great many different things. The cells of the human body each do one thing and one thing only, they are said to be *specialised.* The cells of muscle do one particular thing, the cells of the liver do something else, and the cells of the brain do something else again.

There are many stages between the amœba and the human being. There are animals made up of a few cells which have different functions, animals in the shape of a bag, with cells outside for protection and inside for digestion. Higher up we get simple " organs " set aside for special functions, and all steps of complication are found till the human body is reached—a wonderful culmination.

There are two great divisions of the animal kingdom, " invertebrate " animals and " vertebrate " animals. Vertebrate animals have a spine or backbone, invertebrate animals have not. The bones of the backbone are called " vertebræ."

Some of the invertebrate animals which everybody knows are earth worms, insects, spiders and crabs. The vertebrate animals are fish, snakes, birds, and mammals. Mammals are animals which suckle their young, and include flesh eaters, such as dogs ; grass eaters like cattle ; rodents, which gnaw, like rabbits ; and, highest of all, monkeys, apes and human beings. All these animals are alike in having a backbone. It is the framework on which their whole body is securely built up.

The spine consists of a string of bones, something like beads in a necklace, but each fitting on to its neighbour by joints. In simple animals like fish a pair of bones stick out from each of these vertebrae ; these bones are ribs. At the fore end of the spine is the head or skull, a bony box containing the brain.

Higher Vertebrates

In the higher vertebrates there are always two pairs of limbs, fore and hind limbs, which join on to the spine by means of what are called " girdles." Near the upper or fore part of the spine are two bones on each side, the shoulder-blade behind and the collar-bone in front ; these four bones together make a sort of collar or girdle round the body, and the fore limbs are jointed on to this " girdle." Near the lower or hind end of the spine is another much stronger ring of bone, all in one piece and firmly joined to the spine ; the hind limbs are jointed on to this.

We have spoken of ribs as bones growing out from the spine. In the higher animals the only ribs which grow to any size are the upper ones between the two girdles, these are long bones which grow out and meet in front of the body, enclosing a space, the chest. There is another space between the ribs and the lower girdle, which is called the belly.

The limbs are used for different purposes. In quadrupeds such as horses all the limbs are used for " locomotion "—that is, for walking and running. In birds the hind limbs are used for walking or swimming, the fore limbs as wings for flying. In man the body is held upright, the lower limbs only are used for walking, and the upper ones for grasping and all the different forms of activity which result from the power to grasp objects and move them in all directions. D. W. C.-J.

Continued from page 423.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—XXIV

Agreement (*continued*)

A FEW exceptional cases may be discussed before we leave the subject of the three concords.

The antecedent to a relative may be a whole proposition, as in :—

Ego cum Pompeis in sermonibus versatus sum; quae nec possunt scribi nec scribenda sunt
I have held discourse with Pompey; which things (that is, the things discussed) *neither can be written nor should be written.*

The concord is often determined by the meaning rather than the grammatical form, as in the following, where the neuter substantive refers to male persons :—

Capita conjurationis percussi sunt
The heads of the conspiracy were executed.

A singular noun followed by **cum** with the ablative sometimes takes a plural verb —a construction that would be a solecism in English, as :—

Demosthenes cum ceteris erant expulsi
Demosthenes with the rest was expelled.

Attraction may succeed through the proximity of a singular noun in putting a verb into the singular even though other nouns in the subject are plural, as in :—

Nunc mihi nihil libri, nihil literæ, nihil doctrina prodest
Now neither learning does me good, nor books, nor letters.

Disjunctive particles between singular substantives require a verb in the singular, as :—

Si Socrates aut Antisthenes diceret
If Socrates or Antisthenes said.

But the plural is sometimes used when the two or more nouns, though separated by a disjunctive particle, are regarded as concurring in the act set forth in the verb, as in :—

Si quid Socrates aut Aristippus contra morem civilem fecerint
Whatever Socrates or Aristippus may have done contrary to social usage.

The Cases

The other principal factor in the construction of sentences after agreement or concord is government. Government is the relation of a word to another word required to complete its meaning by which the latter must be in a particular case. Thus the verb **fungor** is said to govern, or take, the ablative case in the sentence **fungor vice cotis**, *I discharge the office of a grindstone*, the preposition **apud** governs the accusative in **apud Ciceronem**, *at Cicero's house*, and the preposition **ab** the ablative, in **ab hoste**, *from an enemy*.

The subject of government can best be studied in a general examination of the uses of the cases.

Nominative Case

The subject of the sentence is put in the nominative case, thus :—

dixit Cicero	*Cicero spoke.*
nox transit	*night passed.*
rex mortuus est	*the king is dead.*

After the verb **essĕ**, *to be*, and certain verbs meaning to become, to seem, to be named, thought, made, etc.; (e.g. **fīō**, *I become*, **crĕŏr**, *I am made*, **vĭdĕŏr**, *I seem*, **hăbĕŏr**, *I am considered*) a substantive in the nominative case is used as secondary predicate, as in :—

Ira iovis magni causa timoris est
The anger of Jove is a cause of great fear.

Cæsar consul fit
Cæsar becomes consul.

Sometimes the nominative case is found standing without a verb, as in :—

Ecce duae litteræ de Varrone
Here (are) two letters from Varro.

Vocative Case

The vocative case denotes the person addressed, and stands as an exclamation, independently of the verb in any sentence appended, thus :—

Matutine pater	*Father Matutinus.*
O Pompei	*O Pompey.*
Huc veni, mi fili	*Come hither, my son.*

Sometimes, though rarely, the nominative is used instead of the vocative, as in :—

Audi tu, populus Albanus
Hear, O thou people of Alba.

Accusative Case

The following are the chief uses of the accusative :—

(*a*) To denote the direct object of a transitive verb.
(*b*) To express the extent or nature of the action.
(*c*) To express motion towards something after verbs or prepositions.
(*d*) To denote the subject to a verb in the infinitive.

(*a*) Transitive verbs are followed by substantives in the accusative case, as in :—

Sophocles Oedipum Coloneum recitavit
Sophocles recited the Oedipus Coloneus.
Arma virumque cano
Arms and the man I sing.
Rex Thracen init
The king enters Thrace.
Cicero iudices allocutus est
Cicero addressed the judges.

In the last two examples the intransitive verbs **ĕō**, *I go*, and **lŏquŏr**, *I speak*, have become transitive by the addition of prepositions as prefixes.

Verbs that are normally intransitive are sometimes found taking the accusative, being given for the moment a transitive meaning. Thus **horrĕō**, *I shudder*, may be taken to mean *I fear*, and **rĕsŏnō**, *I ring again*, may mean *repeat* or *re-echo*. Thus :—

Ariovisti crudelitatem horrebant
They shuddered at the cruelty of Ariovistus.
Formosam resonare doces Amaryllida silvas
Thou teachest the woods to resound with the name of Amaryllis.

With the accusative of the direct object may be classed the accusative used after exclamations expressing strong emotions of some kind or other, as in :—

Heu me miserum	*Alas, wretched me!*
O fortunatos nimium	*O too happy men!*

Verbs meaning *to make, to call, to reckon*, etc. (called factitive verbs) take a double accusative, or rather the object has a predicate in the same case, as in :—

Cæsarem consulem fecerunt
They made Cæsar consul.
Eum, qui hoc facit, avarum possumus existimare?
Can we consider the man who did this avaricious?

(*b*) The extent or nature of the action is a phrase covering such ideas as the time, space, scope, or other limitation defining the action of a verb. We may consider this use under the following heads :—

(1) Accusative expressing the extent of time during which an action lasts, thus :—

Pericles quadraginta annos præfuit Athenas
Pericles ruled Athens forty years.

(2) Accusative expressing the extent of space traversed :—

Tria milia repimus
We crawled three miles.
Ab urbe aberat millia passuum ducenta
He was distant from the city two hundred miles.

(3) Accusative expressing the extent of the action :—

Multum me inimici lædunt
My enemies hurt me much.
Beneficio isto legis nihil utitur
He availed himself not at all of that indulgence of the law.
Hoc Romanos juvabat
To this extent he helped the Romans.

With this may be grouped the so-called "accusative of respect" or accusative of the part affected—a poetical usage, as in :—

Ornatus crines apio
His hair adorned with parsley (literally, adorned as to his hair with parsley).
Stat saucia pectus
She stands wounded in the breast.

The poets also used the accusative neuter of adjectives as an adverbial accusative, thus :—

dulce ridentem	*sweetly smiling.*
acerba tuens	*looking grimly.*

(4) The cognate accusative is the case of a substantive following a verb having a cognate meaning, as :—

vivere vitam	*to live a life.*
servitutem servire	*to serve a slavery.*

It is usually accompanied by an adjective, which serves to qualify the extent of the action, as in :—

Ludum insolentem ludunt
They play an insolent game.
Servitutem duram servimus
We serve a hard slavery.

(5) An accusative defining the nature of the action is added to the accusative denot-

ing the direct object. It is used chiefly after verbs that denote teaching, asking, or concealing, as in :—

Pueros elementa docere
To teach boys the rudiments.

When a verb that takes two accusatives in the active appears in the passive, it retains after it the accusative of the thing taught, asked, or concealed: it is called the retained accusative. Thus :—

Reges semper militiam docti sunt
Kings are always taught warfare.

Exercise 23

Translate into English :—

1. Philosophiae quasi civitatem dare, quae quidem adhuc peregrinari Romae videbatur. 2. Labi, errare, nescire, decipi, et male et turpe ducimus. 3. Pontem in Arari faciendum curat. 4. Tertius frater tres Curiatios, spem Albanae gentis, occidit. 5. Hannibal ita vivebat tanquam nulla in edento et bibendo voluptas esset. 6. Saepissime igitur mihi de amicitia cogitanti maxime illud considerandum videri solet.

Translate into Latin :—

1. Why do you ask me that, I say? 2. He burst into Gaul, which he knew to be hostile and dangerous to him by its warlike power and disposition (arms and spirit). 3. Labienus, to whom Caesar had given the command, was slain by the enemy. 4. We extol those who imitate the philosophers. 5. Caesar's lieutenant-generals will have no authority with the soldiers. 6. Under this oath I have served as a soldier thirty-six years.

Key to Exercise 21

1. What force there is in these few words, if you attend, you will hear. 2. Under the pretence of performing another's duty he strengthened his own power. 3. He put round the city a wall of baked brick cemented in between with sand instead of pitch. 4. To those who were worn out, fresh men succeeded in turn. 5. From the older ox the younger learns to plough. 6. Not ignorant of adversity, I am learned to succour the unfortunate. 7. They appear widely scattered swimming in the vast whirlpool. 8. Unanimity makes even feeble succours strong. 9. Well begun is half done. 10. Remember to preserve amid difficulties an equable mind.

1. Nullum magnum ingenium sine mixtura dementiae fuit. 2. Ignorantia legis neminem excusat. 3. Adde parvum parvo magnus acervus erit. 4. Nomina stultorum parietibus haerent. 5. Sutor ne supra crepidam iudicaret. 6. Damnant quod non intelligunt. 7. Animum rege, qui nisi paret, imperat. 8. Venia necessitati datur. 9. Audit vocatus Apollo. 10. Ab amicis honesta petamus.

E. A. B.

FRENCH.—XXIV

The irregular verbs of the fourth conjugation also fall into two classes differentiated by the ending of the past definite, the first consisting of those having this tense in **-is,** as **dis,** past def. of **dire,** *to say,* or **écrivis,** past def. of **écrire,** *to write,* and the second, of those having this tense in **-us,** as **crus,** past def. of **croire,** *to believe,* or **crus,** past def. of **croître,** *to grow.*

Class I

CONDUIRE, *to conduct*

Conduire, conduisant, conduit, je conduis, je conduisis.

IND. PRES.	IMPERF.
je conduis	je conduisais
nous conduisons	nous conduisions
ils conduisent	etc.
etc.	
PAST DEF.	FUT.
je conduisis	je conduirai
nous conduisîmes	nous conduirons
etc.	etc.
COND. PRES.	IMPER.
je conduirais	conduis
nous conduirions	conduisons
etc.	conduisez
SUBJ. PRES.	IMPERF.
que je conduise	que je conduisisse
que nous conduisions	que nous conduisissions
etc.	etc.

COUDRE, *to sew*

Coudre, cousant, cousu, je couds, je cousis.

IND. PRES.	IMPERF.
je couds	je cousais
il coud	nous cousions
nous cousons	etc.
ils cousent	
etc.	
PAST DEF.	FUT.
je cousis	je coudrai
nous cousîmes	nous coudrons
etc.	etc.
COND. PRES.	IMPER.
je coudrais	couds
nous coudrions	cousons
etc.	cousez
SUBJ. PRES.	IMPERF.
que je couse	que je cousisse
que nous cousions	que nous cousissions
etc.	etc.

CRAINDRE, *to fear*

Craindre, craignant, craint, je crains, je craignis.

IND. PRES.	IMPERF.
je crains	je craignais
il craint	nous craignions
nous craignons	etc.
ils craignent	
etc.	
PAST DEF.	FUT.
je craignis	je craindrai
nous craignîmes	nous craindrons
etc.	etc.
COND. PRES.	IMPER.
je craindrais	crains
nous craindrions	craignons
etc.	craignez
SUB. PRES.	IMPERF.
que je craigne	que je craignisse
que nous craignions	que nous craignissions
etc.	etc.

DIRE, *to say*

Dire, disant, dit, je dis, je dis.

IND. PRES.	IMPERF
je dis	je disais
il dit	nous disions
nous disons	etc.
vous dites	
ils disent	
etc.	
PAST DEF.	FUT.
je dis	je dirai
nous dîmes	nous dirons
etc.	etc.
COND. PRES.	IMPER.
je dirais	dis
nous dirions	disons
etc.	dites
SUBJ. PRES.	IMPERF.
que je dise	que je disse
que nous disions	que nous dissions
etc.	etc.

ÉCRIRE, *to write*

Écrire, écrivant, écrit, j'écris, j'écrivis.

IND. PRES.	IMPERF.
j'écris	j'écrivais
il écrit	nous écrivio
nous écrivons	etc.
ils écrivent	
etc.	
PAST DEF.	FUT.
j'écrivis	j'écrirai
nous écrivîmes	nous écrirons
etc.	etc.
COND. PRES.	IMPER.
j'écrirais	écris
nous écririons	écrivons
etc.	écrivez
SUBJ. PRES.	IMPERF.
que j'écrive	que j'écrivisse
que nous écrivions	que nous écrivissions
etc.	etc.

JOINDRE, *to join*

Joindre, joignant, joint, je joins, je joignis, conjugated like CRAINDRE.

LUIRE, *to shine*

Luire, luisant, lui, je luis, je luisis, conjugated like CONDUIRE; but the past definite and the imperfect subjunctive are not in use. Note that the past participle is **lui.**

NUIRE, *to injure, to be harmful* (to)

Nuire, nuisant, nui, je nuis, je nuisis, conjugated like CONDUIRE.

PRENDRE, *to take*

Prendre, prenant, pris, je prends, je pris.

IND. PRES.	IMPERF.
je prends	je prenais
il prend	nous prenions
nous prenons	etc.
ils prennent	
etc.	
PAST DEF.	FUT.
je pris	je prendrai
nous prîmes	nous prendrons
etc.	etc.
COND. PRES.	IMPER.
je prendrais	prends
nous prendrions	prenons
etc.	prenez
SUBJ. PRES.	IMPERF.
que je prenne	que je prisse
que nous prenions	que nous prissions
qu'ils prennent	etc.
etc.	

RIRE, *to laugh*

Rire, riant, ri, je ris, je ris.

IND. PRES.	IMPERF.
je ris	je riais
nous rions	nous riions
etc.	etc.
PAST DEF.	FUT.
je ris	je rirai
nous rîmes	nous rirons
etc.	etc.
COND. PRES.	IMPER.
je rirais	ris
nous ririons	rions
etc.	riez
SUBJ. PRES.	IMPERF.
que je rie	que je risse
que tu ries	que nous rissions
qu'il rie	etc.
que nous riions	
que vous riiez	
qu'ils rient	

SUIVRE, *to follow*

Suivre, suivant, suivi, je suis, je suivis.

IND. PRES.	IMPERF.
je suis	je suivais
nous suivons	nous suivions
etc.	etc.
PAST DEF.	FUT.
je suivis	je suivrai
nous suivîmes	nous suivrons
etc.	etc.
COND. PRES.	IMPER.
je suivrais	suis
nous suivrions	suivons
etc.	suivez
SUBJ. PRES.	IMPERF.
que je suive	que je suivisse
que nous suivions	que nous suivissions
etc.	etc.

VAINCRE, *to conquer*

Vaincre, vainquant, vaincu, je vaincs, je vainquis.

IND. PRES.	IMPERF.
je vaincs	je vainquais
tu vaincs	nous vainquions
il vainc	etc.
nous vainquons	
vous vainquez	
ils vainquent	

PAST DEF.	FUT.
je vainquis	je vaincrai
nous vainquîmes	nous vaincrons
etc.	etc.
COND. PRES.	**IMPER.**
je vaincrais	vaincs
nous vaincrions	vainquons
etc.	vainquez
SUBJ. PRES.	**IMPERF.**
que je vainque	que je vainquisse
que nous vainquions	que nous vainquissions
etc.	etc.

VOCABULARY

l'affiche, f., *the poster, bill.*
aîné, *eldest.*
l'allemand, *German.*
autrement, *otherwise.*
le cadavre, *the corpse.*
le canif, *the penknife.*
la compagnie, *the company.*
le congé, *holiday, leave.*
le crayon, *the pencil.*
crépu, *crisped, frizzied, woolly, crispy.*
expirer, *to expire, die.*
l'histoire, f., *history.*
un mauvais sujet, *a bad lot, a rake.*
le notaire, *the notary.*
offenser, *to offend.*
prendre congé, *to take leave.*
le tableau, *the picture.*
le ver, *the worm.*
Vienne, *Vienna.*
voiturier, m., *carrier, wagoner, driver.*

Exercise 45

1. Ne craigniez-vous pas d'offenser cette dame ? 2. Je craignais de l'offenser, mais je ne pouvais faire autrement. 3. Que peigniez-vous ce matin ? 4. Je peignais un tableau d'histoire. 5. Conduisiez vous ce jeune homme à l'école lorsque je vous ai rencontré ? 6. Je conduisais mon fils aîné à l'église. 7. Que lisiez-vous ? 8. Je lisais des livres que je venais d'acheter. 9. Que vous a-t-on pris ? 10. On m'a pris mes livres, mes crayons, et mon canif. 11. Je ne connais pas celui qui les a pris, mais je sais qu'il demeure ici. 12. Dites-moi où demeure M. Harcourt. 13. Il y a deux heures qu'il écrit. 14. Combien de temps avez-vous appris l'allemand ? 15. Il y a un mois qu'il demeure à Paris. 16. Combien y a-t-il de Paris à Londres ? 17. Y a-t-il longtemps que vous êtes ici ? 18. Y a-t-il longtemps que la compagnie est venue ? 19. Ah ! ce n'est pas toujours profit d'être un mauvais sujet. 20. Comme les vers qui seraient au cadavre d'un homme avant qu'il n'ait expiré.

Exercise 46

1. How long has he been living at Paris ? 2. He has been living there these ten years. 3. He has been in England a year now. 4. We have been here more than two months. 5. Do you know how far it is from Paris to Vienna ? 6. Is it long since you read this bill ? 7. I have been waiting for it more than a year. 8. Did the notary accompany you yesterday ? 9. He accompanied me as far as your brother's. 10. Did your companion take leave of you yesterday ? 11. He took leave of me this morning. 12. He painted all day yesterday, but the portrait is not yet finished. 13. He was not afraid of falling, but he was afraid of making a mistake. 14. Were you taking your son to school ? 15. I was taking him to church. 16. What was the gentleman reading ? 17. He was reading a letter that he had just received. 18. Do you not know where my father lives ? 19. I know where he lives, but I have not time to go to his house to-day. 20. How long has your son been learning Greek ?

E. A. B.

GERMAN.—XXI

Simple Prefixes used to form Separable Compounds (*Continued*).—Los.—This is properly an adjective meaning "loose," "separate," and is consequently always used to denote separation. Thus: arbeiten, *to work*, losarbeiten, *to work loose, to loosen;* laſſen, *to let*, loslaſſen, *to let loose, let go.* Hence, with certain verbs it reverses the meaning of the simple verb. Thus: binden, *to bind*, losbinden, *to unbind;* kuppeln, *to couple*, loskuppeln, *to uncouple, unleash.*

It intensifies the meaning of simple verbs in such compounds as löſen, *to loosen*, loslöſen, *to separate, sever.*

It also denotes commencement of an action. Thus: gehen, *to go*, losgehen, *to go off* (of a gun), *to begin;* hetzen, *to hunt*, loshetzen, *to set* (a dog) *upon* (someone).

Mit.—This always has the meaning of "with," "in company with," "at the same time." Thus: nehmen, *to take*, mitnehmen, *to take with one;* arbeiten, *to work*, mitarbeiten, *to co-operate;* bieten, *to bid*, mitbieten, *to bid at the same time;* reden, *to speak*, mitreden, *to join in a conversation, to have a voice in.*

Nach.—This denotes "after" in the various senses of the English word. Thus: kommen, *to come*, nachkommen, *to come later;* ſehen, *to see*, nachſehen, *to look after, scrutinise, to overlook;* ſtreben, *to strive*, nachſtreben, *to pursue, to emulate;* ſagen, *to say*, nachſagen, *to repeat* (after someone else).

Nieder.—This always means "down." Thus: laſſen, *to let*, (ſich) niederlaſſen, *to settle* (in a place); gehen, *to go*, niedergehen, *to go down, to set* (of the sun).

Ob.—This denotes "over" or "on." Thus: walten, *to rule*, obwalten, *to rule over;* ſiegen, *to be victorious*, obſiegen, *to vanquish;* liegen, *to lie*, obliegen, *to apply oneself to*, (impersonally) *to be incumbent on.*

Vor.—This means "before" or "forward." Thus: ziehen, *to draw*, vorziehen, *to draw forth, to prefer;* ſpielen, *to play*, vorſpielen, *to play before people;* machen, *to make*, vormachen, *to place* or *tie* (a thing) *in front* (of one), *to do* (a thing) *before people* (so that they may imitate it), i.e. to show how to do; feiern, *to celebrate*, vorfeiern, *to celebrate beforehand;* ſehen, *to see*, vorſehen, *to look before, to provide*, or *to provide for.*

Weg.—This means "away." Thus: nehmen, *to take*, wegnehmen, *to take away;* laufen, *to run*, weglaufen, *to run away;* ſpülen, *to wash*, wegſpülen, *to wash away.*

Zu.—This denotes "to" in the ordinary senses of the preposition, and also "shut" or "closed." Thus: laufen, *to run*, zulaufen, *to run towards*; ſehen, *to see*, zuſehen, *to look on*; tun, *to do*, zutun, *to add*; ſagen, *to say*, zuſagen, *to promise, consent, accept*; ſtimmen, *to vote*, zuſtimmen, *to agree*.

In the sense of closing: machen, *to make, do*, zumachen, *to shut*; ſchließen, *to lock*, zuſchließen, *to lock up*.

Zurück. — This means "back." Thus: kommen, *to come*, zurückkommen, *to return, come back*; weiſen, *to point out*, zurückweiſen, *to rebuff, to refuse*; ſetzen, *to set*, zurückſetzen, *to set back, to neglect*.

There are a certain number of prefixes that can be used either separably or inseparably. These are durch, hinter, über, unter, um, wider and wieder. In verbs *separably* compounded with these, both members of the compound retain their full meaning, and the accent falls on the prefix. In verbs *inseparably* compounded we often find an altered or a figurative sense; these are accented on the stem syllable of the verb.

Compounds of Intransitive Verbs.—The Transitive compounds of these formed with the above prefixes are usually inseparable. The Intransitive compounds are separable. Thus: durchge'hen (inseparable) means, 1, *to traverse*, 2, *to penetrate*, 3, *to peruse*; durch'gehen (separable) means, 1, *to pass through*, 2, *to pass* (become law), 3, *to run away*; überfah'ren (inseparable) means *to run over* (with a carriage), ü'berfahren (separable) means *to go* or *drive across*.

The above applies especially to compounds with durch. As regards compounds of transitive verbs, the question whether they are separable can usually be decided by seeing whether the prefixes are really used as if they were adverbs, in which case the compound is a separable one.

VOCABULARY

Tor, s.n.2, *gate*.
vorüberfahren, s., *to drive past*.
einförmig, *uniform*.
Gitter, s.n.1, *railing*.
Ebene, w.f., *plain*.
endlos, *endless*.
ſich aus'breiten, w., *to spread*.
Pelz, s.m.2, *fur*.
Stirn, w.f., *forehead, brow*.
Reiter, s.m.1, *rider*.
luſtig, *gay, jaunty*.
vorn, *in front*.
Stroh, s.n., *straw*.
Knecht, s.m.2, *farm servant*.
Bürger, s.m.1, *citizen*.
fegen, *to sweep*, w.
Beſen, s.m.1, *broom*.
Halm, s.m.2, *blade, wisp*.
Feld, s.n.3, *field*.
breit, *broad*.
Graben, s.m.1, *ditch*.
waten, w., *to wade*.
aus'gefahren, *worn out by being driven over*.
gelb, *yellow*.
Grün, s.n., *green*.
Maus, s.f.2, *mouse*.
Grube, w.f., *hole*.
emſig, *busy, diligent*.
Kraft, s.f.2, *strength*.
Hügel, s.m.1, *hill*.
unterbre'chen, s., *to interrupt, break*.
Boden, s.m.1, *soil, ground*.
Stelle, w.f., *place, spot*.
aus'höhlen, w., *to hollow out*.
Weide, w.f., *willow*.
Rute, w.f., *rod, twig*.
flattern, w., *to flutter*.
trübe, *dark, muddy*.
zwerghaft, *dwarflike*.
Ruhe, w.f., *rest*.
Krähe, w.f., *crow, rook*.
Schrei, s.m.2, *cry, scream*.
fliegen, s., *to fly*.
Wanderer, s.m.1, *wanderer, pedestrian*.
hüllen, w., *to wrap*.
neben, *beside*.
Mütze, w.f., *cap*.
Ohr, n. (mixed), *ear*.
hocken, w., *to crouch*.
Bund, s.m.2, *bundle*.
Acker, s.m.1, *arable ground, field*.
peitſchen, w., *to whip*.
rieſig, *gigantic*.
Sand, s.m., *sand*.
Stoppel, w.f., *stubble*.
Straße, w.f., *road*.
Weg, s.m.2, *way, path, track*.
Reihe, w.f., *row*.
bald . . . bald, *at one time . . . at another*.
Pfütze, w.f., *puddle*.
dürftig, *scanty*.
überall, *everywhere*.
Eingang, s.m.2, *entrance*.
an'legen, w., *to place*.
Maulwurf, s.m.2, *mole*.
arbeiten, w., *to work*.
Kette, w.f., *chain*.
Senkung, w.f., *hollow*.
ſchlammig, *slimy*.
ſtrecken, w., *to stretch*.
Stamm, s.m.2, *stem, trunk*.
verkrüppeln, w., *to cripple*.
welk, *faded*.
herunter, *down*.
Buſch, s.m.2, *bush, clump*.
Kiefer, w.f., *pine tree*.
Platz, s.m.2, *place*.
auf'ſcheuchen, w., *to scare up*.
Haupt, s.n.3, *head*.
Fuhrwerk, s.n.2, *vehicle*.

Exercise 49

An einem kalten Oktobertage fuhren zwei Männer bei dem Torgitter[1] der Stadt Rosmin vorüber in die Ebene, welche ſich einförmig und endlos vor ihnen ausbreitete[2]. Anton ſaß in ſeinen Pelz gehüllt, den Hut[3] tief auf der Stirn, neben ihm der junge Sturm im alten Reitermantel[4], die Soldatenmütze[5] luſtig auf einem Ohr. Vorn hockte auf einem Strohbund der Knecht eines Ackerbürgers[6] und peitſchte die kleinen Pferde. Der Wind fegte mit ſeinem rieſigen Beſen Sand und Strohhalme über die Stoppelfelder, die Straße war ein breiter Feldweg, ohne Gräben und Baumreihen, die Pferde wateten bald durch ausgefahrene[7] Waſſerpfützen, bald durch tiefen Sand. Gelber Sand glänzte zwiſchen dem dürftigen Grün der Äcker überall, wo eine Feldmaus den Eingang zu ihrer Grube angelegt[8], oder wo der emſige Maulwurf nach Kräften[9] gearbeitet hatte, die Ebene durch kleine Hügelketten zu unterbrechen. In den Senkungen des Bodens ſtand ſchlammiges Waſſer; an ſolchen Stellen ſtreckten die ausgehöhlten Stämme alter Weiden ihre verkrüppelten Arme in die Luft, ihre Ruten peitſchten einander im Wind, und die welken Blätter flatterten herunter in das trübe Waſſer. Hier und da ſtand ein kleiner Buſch zwerghafter Kiefern, ein Ruheplatz[10] für Krähen, die durch den Wagen aufgeſcheucht[11], mit lautem Schrei über die Häupter der Reiſenden flogen. Kein Haus war zu ſehen[12] an der Straße, kein Wanderer, und kein Fuhrwerk.

Guſtav Freytag.

NOTES:

(1) Torgitter, literally *gate railing*. (2) ſich ausbreitete, a good example of the reflexiye use of a transitive verb in German, where we can use the verb in English in an intransitive sense. (3) den Hut, the accusative, an absolute construction (*see* Lesson XV.). (4) Reitermantel; there are a large number of compound nouns in this extract; we have given the meaning of the separate members of the compounds in the vocabulary, and it will be good practice for the student to find the English translation of the compounds himself. (5) Soldatenmütze, accusative absolute (and *see* 4). (6) Ackerbürger,

this means a town-dweller who occupies himself with agriculture. (7) ausgefahren; see notes on the separable prefix aus in Lesson 20. (8) angelegt; when two verbs are used successively in the same compound tense and take the same auxiliary, the latter is often used with the last verb only (in this case gearbeitet), and must be supplied with the first verb. (9) nach Kräften, *to the best of its ability*. (10) Ruheplatz, in apposition to Busch. (11) aufgescheucht; this Passive Participle qualifies the relative pronoun die. (12) zu sehen: the infinitive with zu used after sein, though active in form, is passive in meaning

VOCABULARY

name, Name, m. (mixed).
single, unverheiratet.
a year, jährlich.
affect, berühren, w.
design (purpose), Zweck, s.m.2.
nonsense, Unsinn, s.m.2.
to fall in love with, sich verlieben (w.) in.
as soon as, so bald.
assure, versichern, w.
establishment (match), Partie, w.f.
merely, nur.
account (reason), Grund, s.m.2.
married, verheiratet.
go on, fortfahren, s. (sep.).
fine, schön.
think of, denken an (gov. acc.).
settle, sich niederlassen s (sep.).
very likely, höchst wahrscheinlich.
call on, besuchen, w.
come, herkommen, s.
consider, bedenken.
determine, sich entschließen, s.
in general, im Allgemeinen.

Exercise 50 (*Continued from Exercise* 48)

"What is his name[1]?"
"Bingley."
"Is he married[2] or single?"
"Oh, single,[3] my dear, to be sure."
"He is a single man of large fortune," went on Mrs. Bennet. "And worth[4] four or five thousand a year. What a fine[5] thing for our girls!"
"How so? How can it affect them?"
"My dear Mr. Bennet," replied his wife, "how can you be so tiresome[6]? You must know that I am thinking of his marrying[7] one of them."
"Is that his design in settling here[8]?"
"Design! Nonsense! How can you talk so? But it is very likely that he may fall[9] in love with one of them, and therefore you must call on him as soon as he comes."
"It is more than I engage for, I assure you."[10]
"But consider your daughters. Only think what an establishment it would be for one of them! Sir William and Lady Lucas are determined to go merely on that account,[11] for in general, you know,[12] they visit no newcomers."[13]

NOTES:

(1) Say, how is his name, or how is he called? (to be called, heißen). (2) Married; the simple verb heiraten is used of the two contracting parties in a marriage; the compound verheiraten is used of the person who marries them (e. g. the officiating clergyman); for the past participle referring to the state of being married (as here) the past participle of the compound is used. (3) Say, of course (natürlich) single, and omit "to be sure." (4) Worth . . . say, has four to (bis) five thousand pounds sterling income (Pfund Sterling Einkommen). (5) Say, how fine for. (6) Say, how can you annoy (ärgern, w.) me so? (7) Say, thinking of it that he may marry (Pres. Conj.). (8) Say, will he settle here for this purpose? (9) May fall in love; use the simple Pres. Ind., falls in love. (10) Say, I assure you that I do not engage to do that, ich versichere dich daß ich mich dazu nicht verpflichte. (11) On that account, aus diesem Grunde. (12) Say, as (wie) you know. (13) newcomers, say, new neighbours (Nachbaren).

Key to Exercise 47

THE ELFKING

Who rides so late through the night and the wind? It is a (the) father with his child; he has his arm well round the boy (has the boy well in his arm), he holds him securely, he keeps him warm.

My son, why dost thou hide thy face so fearfully?—Father, dost thou not see the Elfking? the king of the elves with a crown and train?—My son, it is a streak of mist

"Thou, dear child, come, go with me. I will play most beautiful games with thee; there is many a lovely flower on the shore, my mother has many a golden robe."

My father, my father, and dost thou not hear what the king of the elves is promising me softly?—Be easy, rest easy, my child, the wind is rustling among dry leaves.

"Pretty boy, wilt thou go with me? My daughters shall tend thee well; my daughters sing and dance at night, and will rock and dance and sing thee to sleep."

My father, my father, and dost thou not see there the Elfking's daughters at that dark spot?—My son, my son, I see it clearly: the old willows are shimmering greyly.

"I love thee, thy beautiful form allures me; and if thou art not willing, then I will use force."—My father, my father, now he is taking hold of me! The Elfking has hurt me!

The father is filled with horror; he rides quickly; he holds in his arms the moaning child; with terrible trouble he reaches home; the child in his arms was dead.

Key to Exercise 48

Es wird allgemein als Wahrheit anerkannt, daß ein lediger Mann im Besitz eines guten Vermögens, eine Frau nötig hat.

Wie wenig man auch von den Gefühlen eines solchen Mannes wissen mag, wenn er sich in einer Gegend niederläßt, wird er von den Familien der Nachbarschaft als das unbestreitbare Eigentum irgend einer ihrer Töchter angesehen.

„Mein lieber Bennet," sagte ihm eines Tages seine Frau, „hast du gehört daß Netherfield Park endlich vermietet ist?"

Herr Bennet erwiederte aber daß er es nicht gehört hätte.

„Es ist aber der Fall," fuhr sie fort, „denn Frau Long ist eben hier gewesen, und sie hat mir alles erzählt."

Herr Bennet gab keine Antwort.

„Willst du wissen wer es genommen hat?" rief seine Frau ungeduldig aus.

„Du willst es mir gern sagen, und ich habe nichts dagegen es zu hören."

„Aber, mein Lieber, du mußt es wissen. Frau Long sagte daß ein junger Mann von großem Vermögen aus dem Norden Englands, Netherfield gemietet habe; daß er Montag in einem Wagen mit vier Pferden hergekommen ist um dem Wohnsitz zu besichtigen, und daß er ihm so gut gefallen hat, daß er sofort mit Herrn Morris übereingekommen ist; daß er vor Michaelis in Besitz treten soll, und daß einige seiner Dienstleute schon Ende nächster Woche einziehen sollen."

M. A. L.

RUSSIAN.—XI

The Noun

Contractions and Amplifications

107. THE Nouns мать, *a mother*, and дочь, *a daughter*, are declined as if they originally were мáтерь, дóчерь.

108. The following Nouns leave out the **о** in all the cases of singular and plural :

Ротъ, *the mouth.* У́голь, *coal.*
Сонъ, *the sleep, a dream.* Кусóкъ, *a piece.*
У́голъ, *a corner.* Убы́токъ, *a loss, damage.*

109. The following leave out the second "о" in all the cases of singular and plural :

Хлопóкъ, *raw cotton.* Посóлъ, *a consul, ambassador.*
Огóнь, *fire, a light.* Звонóкъ, *the bell.*

110. The third "о" is left out in declining the following :

Молотóкъ, *a hammer.* Потолóкъ, *the ceiling.*

111. The following leave out the "е" in all the cases of singular and plural :

Купéцъ, *the merchant.* Си́тецъ, *chintz, print.*
Торгóвецъ, *the dealer.* Свинéцъ, *lead.*
Образéцъ, *the model, sample, pattern.* Вѣтеръ, *the wind.*
Конéцъ, *the end.* День, *the day.*
Кáмень, *the stone.*

112. The following leave out the second "е" in all cases :

Ремéнь, *a belt, strap.* Пéрстень, *a ring with a stone.*

113. The following leave out the "ё" in all the cases of singular and plural :

Котёлъ, *the kettle, boiler.* Ковёръ, *the carpet.*
Крючёкъ, *a hook.*

114. The "е" of the following is replaced by "ь" in all the cases :

Пáлецъ, *a finger.* Владѣлецъ, *a possessor, owner.*

115. The "ё" of the following is replaced by "ь" in all cases :

Лёнъ, *flax.* Огонёкъ, *small fire.*
Лёдъ, *ice.* Кошелёкъ, *a purse.*

116. The "ё" is replaced by "й" in all cases of the following :

Заёмъ, *the loan.* Наёмъ, *the hire.*

117. The "е" of the following is changed to "ь" for all cases :

Соловéй, *the nightingale.* Ручéй, *the brook.*

118. The following Feminine Nouns, used only in singular, are declined thus :

Nominative	*Genitive*	*Dative*
Любóвь, *love*	Любви́	Любви́
Рожь, *corn*	Ржи	Ржи
Ложь, *a lie*	Лжи	Лжи
Accusative	*Instrumental*	*Prepositional*
Любóвь	Любóвью	Въ любви́
Рожь	Рóжью	О ржи
Ложь	Лóжью	Во лжи

119. The following Masculine Nouns are used in plural only :

Часы́, *a clock, watch.* Щи́пцы, *pincers.*
Вѣсы́, *a scale.* Тиски́, *a vice.*
Обóи, *wallpaper.*

120. The following Feminine Nouns are used in plural only :

Дрóжки, *a cab.* Сáни, *a sledge.*
Дрóжди, *yeast.* Сýтки, *a full day* (24 hours).
Нóжницы, *scissors.*

121. The following Neuter Nouns are used in plural only :

Ворóта (or Воротá), *the gate.* Черни́ла, *ink.*
Дровá, *firewood.* Бѣли́ла, *white-lead.*

Practice XXVI

(*a*) Express the following in Prepositional Singular preceded by "Во" :
Ротъ, сонъ, ложь.

(*b*) The following in Dative Singular with "по"
Лёдъ, любóвь, звонóкъ, образéцъ, вѣтеръ, ковёръ.

(*c*) The following in Instrumental Singular with "съ" :
У́голь, огóнь, посóлъ, купéцъ, ремéнь, владѣлецъ.

(*d*) The following in Genitive Singular with "изъ" :
Хлопóкъ, лёнъ, свинéцъ, кáмень, ручéй.

(*e*) The following in Prepositional Plural with "Въ" :
У́голъ, кусóкъ, конéцъ, день, тиски́, сáни, ворóта (or ворóта).

The Verb

The Aspects

122. The Russian verbs are classified in four so-called "Aspects," which are known as :

(*a*) The *Imperfective*, when the verb denotes an uncompleted action or event. Example : Дѣлать, *to do*. It is used in all the three tenses, as follows :

Present	*Past*	*Future*
Я дѣлаю, *I am doing.*	Я дѣлалъ, *I did.*	Я бу́ду дѣлать, *I shall do.*

(*b*) The *Iterative*, denoting that the action or event is composed of a number of parts or repeated. Example : Выдѣлывать, *to prepare*. This also is used in all the three tenses, as follows :

Present	*Past*
Я выдѣлываю, *I am preparing.*	Я выдѣлывалъ, *I used to prepare.*

Future

Я буду выдѣлывать, *I shall be preparing.*

(*c*) The *Perfective*, denoting full completion of an action or event. Example : Сдѣлать, *to have done completely* (the action is entirely finished). It is only used in two tenses, Past and Future, as follows :

Past : Я сдѣлалъ, *I have completely done.*
Future : Я сдѣлаю, *I shall do it all.*

What appears in form to be the present tense of the Perfective aspect is actually the future.

(*d*) The *Semelfactive*, denoting suddenness or singleness of action or event. Examples: Кри́кнуть, *to exclaim ;* Лопнуть, *to crack, burst.* It has only the Past and Future, as follows:

Past	*Future*
Я кри́кнулъ, *I have exclaimed.*	Я кри́кну, *I shall exclaim.*
Оно́ ло́пнуло, *it has burst, cracked.*	Оно́ ло́пнетъ, *it will burst, crack.*

123. The main characteristics of the Aspects, as exemplified above, are:

(*a*) Imperfective occurs with a variety of endings in the Infinitive, and its Future Tense is formed with the help of the verb быть.

(*b*) The Iterative is built up from the Imperfective or, sometimes, from the Perfective by adopting for the Infinitive the ending of -ивать or -ывать. Its Future Tense is also formed with the help of the verb быть.

(*c*) The Perfective is in the great majority of cases built up from the Imperfective in one of two ways:

I. By changing the ending ать, or -ять, of the Infinitive Imperfective into -ить, as exemplified below:

Imperfective	*Perfective*	*Meaning in both cases*
Лиша́ть	Лиши́ть	*to deprive.*
Сочиня́ть	Сочини́ть	*to compose.*
Покупа́ть	Купи́ть	*to buy.*

II. By prefixing to the Imperfective some preposition, as in the following examples:

Imperfective	*Perfective*
Слать, *to send*	Вы́слать, *to send out.* Отосла́ть, *to send off.* Переосла́ть, *to send over.*
Писа́ть, *to write*	Записа́ть, *to write down.* Подписа́ть, *to sign.* Вписа́ть, *to inscribe.*

The Future Tense of the Perfective is self-contained and is conjugated in the same way as the Present Tense of the Imperfective. Example: Рабо́тать (Imperfective), *to work ;* Вы́работать (Perfective), *to elaborate.*

Imperfective Present	*Perfective Future*
Я рабо́таю, *I am working.*	Я вы́работаю, *I shall work out.*
Вы рабо́таете, *you are working.*	Вы вы́работаете, *you will work out.*

(*d*) The Semelfactive (= done once only) is in various instances built up from nouns, verbs, interjections, etc. It has for its ending in the Infinitive: -нуть, and is conjugated in the Past and Future Tenses after the examples given in Rule 122.

VOCABULARY

NOTE.—The capitals in brackets after the Russian Infinitives are the initials of the Aspects, for the student's guidance.

Посѣти́ть (P.)	(pa-sye-tít'),	*to visit, call on.*
Встрѣ́титься (P.)	(vstryé-tit'-sya),	*to meet together.*
Обожда́ть (P.)	(a-ba-zhdát'),	*to await, wait for.*
Слу́чай	(slú-chaĭ),	*an opportunity.*
Заплати́ть (P.)	(za-pla-tít'),	*to pay.*
Де́ньги	(dyén'-gi) (hard),	*money.*
Крича́ть (Im.)	(kri-chát'),	*to shout.*
Мѣсяцъ	(myé-syatz),	*the month, a month's time.*
Путь	(put'),	*the road, way.*
Зайти́ (P.)	(zaĭ-tí),	*to come in, call on.*
Карма́нная кни́жка	(kar-mánn-naya knísh-ka),	*a pocket-book, note-book.*
Отойти́ (P.)	(a-taĭ-tí),	*to go off, be sent off.*
Забра́ть (P.)	(za-brát'),	*to take away.*
Годи́ться (Im.)	(ga-dit'-sya),	*to be of use for, good for.*
Пересчита́ть (P.)	(pe-re-schi-tat'),	*to overcharge.*
Ка́ждый предме́тъ	(kázh-dü pred-mét),	*every article.*
Вина́	(vi-ná),	*the fault.*
Вздорожа́ть (Im.)	(vzdo-ra-zhát'),	*to become dearer.*
Спроси́ть (P.)	(spra-sít'),	*to inquire.*
Нѣсколько разъ	(nyé-skol'-ko raz),	*several times.*
Забы́ть (P.)	(za-bŭt'),	*to forget.*
Получи́ть (P.)	(pa-lu-chít'),	*to receive.*
Перево́дъ	(perevód),	*a remittance, draft.*
Непремѣнно	(nye-pre-myén-no),	*without fail.*
Переговори́ть (P.)	(pe-re-ga-va-rit'),	*to talk over.*
Пото́мъ	(pa-tóm),	*afterwards.*
Пойти́ (P.)	(paĭ-tí),	*to go over.*
Новинки	(na-vin-ki),	*novelties.*
Посчита́ть (P.)	(pa-schi-tat'),	*to charge a price.*
Счита́ть (Im.)	(schi-tat),	*to charge a price.*
Потеря́ть (P.)	(pa-tye-ryát'),	*to lose.*

Exercise 18

Translate the following into English:

1. Вашъ представи́тель посѣти́лъ меня́ на про́шлой (last) недѣлѣ.
2. Я встрѣ́чусь съ Ва́ми въ Ло́ндонѣ.
3. Я обожда́лъ э́тотъ слу́чай два го́да.
4. Заплати́те мнѣ мой (my) де́ньги.
5. Не крича́йте. Я Вамъ заплачу́ че́резъ (in) мѣсяцъ.
6. По пути́ я зашёлъ къ купцу́ Д.
7. Я записа́лъ Вашъ а́дресъ въ мое́й карма́нной кни́жкѣ.
8. Я зайду́ къ Вамъ ве́черомъ.
9. Когда́ отойдётъ мой това́ръ?
10. Онъ отошёлъ вчера́.
11. Забери́те Ва́ши образцы́.
12. Вашъ това́ръ не годи́тся.
13. Вы пересчита́ли мнѣ по рублю́ на каждый предме́тъ.
14. Не моя́ вина́: това́ръ вздорожа́лъ.
15. Почему́ Вы меня́ не спроси́ли?
16. Я Васъ спра́шивалъ нѣсколько разъ.
17. Да, да, я объ этомъ забы́лъ.
18. Получи́ли ли Вы уже́ мой перево́дъ?
19. Когда́ Вы его́ (it) вы́слали?
20. Вы непремѣнно полу́чите его́ за́втра у́тромъ.

Exercise 19

Translate the following into Russian:

1. I shall pay you a visit in a week's time.
2. What will you buy to-day?
3. I shall buy nothing.
4. Where shall we meet to-morrow?
5. I shall wait for you at the corner.
6. What have you paid for the carpets?

A. C.

Continued from page 423.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

NORTH AMERICA.—IV

THE United States occupies the entire central region of the North American Continent and extends from 25° north latitude—the extreme southern extremity of Florida—to latitude 49° north, where lies the boundary with Canada. Between the United States and Mexico the boundary is irregular, more than one half of it being formed by the Rio Grande River. The extreme north-west of the continent (the peninsula of Alaska) is also a territory of the United States, having been acquired in the year 1867 by purchase from Russia.

The U.S.A.

The country is divided into forty-eight states and one federal district (the District of Columbia, which is only twenty square miles in area and contains the capital city of Washington), though six territories exist separated from the main body of the country in various parts of the world.

The states vary in size, from Texas, with over 250,000 square miles of territory, to Delaware, with but just over 2,000 square miles. The government of the United States is that of a federal republic, the individual states having powers concerning matters which affect themselves alone, but the federal government retains in its hands the powers concerning matters which affect the states collectively, such as foreign affairs, defence, etc.

The area of the continental portion of the United States, excluding Alaska, is just over 3,000,000 square miles—rather less than the area of the British Dependencies of the same continent. The population is about 100,000,000, ranging in density from less than one inhabitant to the square mile in Nevada to over 500 in Rhode Island.

The east coast of the Atlantic and Gulf of Mexico seaboards possesses many excellent harbours, but the Pacific coast is nearly unbroken, and has but two harbours of the first class, San Francisco and Puget Sound.

The physical topography of the country has been almost sufficiently described above in the general survey of the continent, of which the United States is so large and so important a member. Broadly speaking, it consists, as we have seen, of an eastern plain, continuous round the coast into the Gulf of Mexico, an eastern highland system bounding the great plains, prairies, and plateaux of the centre of the continent, and on the west the great mountain system of the Cordillera, which has a breadth of 700 to 1,000 miles.

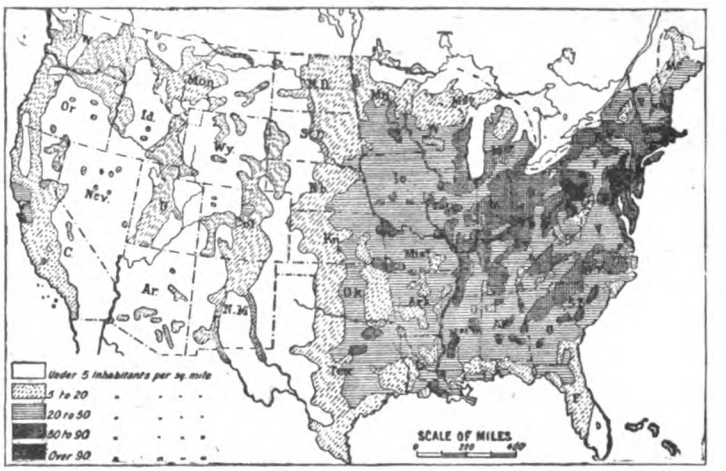
The eastern states were originally covered with vast forests, but these have to a great extent been cut down. The lumber industry, however, still flourishes, especially in Maine, and wherever the forests still remain. Farther south, in New Hampshire, the climate is sufficiently damp to permit of the manufacture of cotton, and at Manchester and Lowell this industry is carried on. Boston, in Massachusetts, is an important port, and a great sugar refining centre. It has also been described as the literary metropolis of the country.

Manufactures

The "New England States" of New York, New Jersey, Pennsylvania, Ohio, Michigan and Illinois are the principal manufacturing districts of the United States, the population being largely engaged in the manufacture of iron and steel, boots and shoes, railway carriages and wagons, cotton goods, flour, furniture, paper, woollens and hundreds of other industries. In Pennsylvania particularly the iron and steel industries are of enormous importance. New York, in the state of the same name, is the largest city in the Union and the second largest of the world. It is the first port of the United States, and possesses an excellent harbour, with miles of wharves along the shores of Manhattan and Long Islands. Other notable ports of this district are Philadelphia, on the Delaware River, also an industrial city manufacturing woollens, iron

goods, etc., and Baltimore, at the head of Chesapeake Bay, noted for oysters.

Farther inland, on the Alleghenny plateau and west of this, are the States of Virginia, North Carolina, Kentucky and Tennessee, the chief tobacco-growing regions. The soil here is remarkably fertile, and this is due to a kind of limestone occurring in the rocks. In some parts this limestone is very porous, and the rain, soaking through it, has dissolved out huge undergrouhd caverns, of which the Mammoth Cave, in Kentucky, is the most remarkable. Pittsburg, in Pennsylvania, to the north of the Allegheny Range, is the centre of a great iron-smelting district, and is also the largest glass-producing town in the States, in the manufacture of which natural gas was formerly used, as this is the best fuel for the purpose.



MAP SHOWING DENSITY OF POPULATION IN THE U.S.A.

The Prairie region of the United States is of a more or less open nature; great forests are absent, except in the regions bordering the Great Lakes, where there is an extensive lumber industry. The country generally is favourable for agriculture owing to the fertile nature of the soil, which is composed of the debris of glaciated rocks and moraines. Large crops of wheat and maize are grown, and an enormous number of hogs are reared, which, with the cattle bred in the region, has led to the important meat-canning industries of Chicago. The Great Lakes carry an enormous amount of the traffic of the neighbourhood, such as coal from Pennsylvania, and iron and copper from the shores of Lake Superior.

THE U.S.A.: STATES AND THEIR CAPITALS.

Chicago, the second city for size in the United States, is on the shores of Lake Michigan, and owing to its position the railways from the west have to pass through it in rounding the southern end of the lake. Among other reasons, this has made it a great centre for trade, and the lake has been deepened to afford a good harbour for water-borne commodities.

St. Louis, near the junction of the Missouri with the Mississippi, occupies a central position in this prairie region, and is an important centre for dispatching the products of the whole district either southwards to the Gulf of Mexico or eastwards to the Atlantic. The Mississippi River is a convenient route for the transportation of goods to the Gulf ports.

In the southern states, and especially in those districts forming the alluvial plain of the lower Mississippi and the coastal plains of the Gulf and the Atlantic, are the great cotton-growing regions of the United

Photo: Underwood and Underwood.

PITTSBURG, PENNSYLVANIA, AS SEEN FROM ACROSS THE RIVER.

States, of which the state of Texas is perhaps the most important. The cotton is grown from seed planted in the spring of each year, and requires for its best development a considerable amount of heat and moisture. During the autumn the seed vessels which are filled with the down are collected, chiefly by negro labour, and the down is separated from the seed before exportation.

The chief cotton port is New Orleans, on the delta of the Mississippi, though Mobile and Galveston, also on the Gulf of Mexico, are likewise much concerned in the shipment of this and other commodities.

In North and South Carolina, Georgia, etc., rich crops of rice are grown on the marshy ground behind the lines of islands and sandbanks which skirt the Atlantic coast. Florida grows early vegetables and pineapples, as its southern position causes it to enjoy a high temperature. But occasionally the crop has been spoiled by a severe spell of cold weather.

Cattle Rearing

On the Great Plains, extending from the Prairies to the base of the Rocky Mountains, the chief industry is that of cattle rearing. Owing to the deficient rainfall agriculture is, generally speaking, unprofitable, but the mildness of the climate enables cattle to be out all the year round. A single ranchman, it is said, may be possessed of as many as 20,000 head of cattle, and his herds may be as far as thirty miles from his ranch house.

Denver, in Colorado, is the largest town of the Great Plains; it has big furnaces for smelting iron and other metals derived from the Rocky Mountains.

The western portion of the United States comprises the Rocky Mountains and the associated ranges. The physical characteristics of this region have already been noticed in our survey of the continent. Commercially the whole of this region is noted for its mineral wealth, copper, lead, silver, gold, etc., being found, as well as coal. The copper produced in Montana is now more than that supplied by the famous Lake Superior district. South of San Francisco quicksilver is mined in the Sierra Nevada Range.

The Californian Valley produces wheat and fruits of all sorts, much of which is exported, both fresh and canned. The port of San Francisco, which is the natural outlet of the region, has a fine harbour, and many of the Pacific steamer routes converge upon it.

The United States, with its vast natural resources, has an enormous commerce, both

internal and foreign. With few exceptions, such as the entirely tropical products like tea, coffee, rubber, etc., the country could be self supporting. But as the demand is greater than the supply, even in articles grown and manufactured within its borders, a foreign trade is essential.

Factors of Wealth

Though the United States has developed a very large export trade, the commerce it carries on within its borders is greater. Its wonderful facilities of transport and its network of railways, canals and great rivers, its wealth in minerals and raw materials, and its industries are among the factors which make the country one of the wealthiest in the world. The greatest employers of labour are to be found in the lumber and timber industry, cotton and woollen goods, machine shops, slaughtering and meat preserving, railway-car shops, and the manufacture of iron and steel.

The United States holds the foremost place in the yield of coal, lead, iron; its output of gold and silver is large.

Another prime source of its mineral wealth is petroleum. The oil produced from the Appalachian field is said to be the highest quality crude oil in the world.

For the transportation of the enormous quantity of goods the United States is well supplied with railways, four great lines having transcontinental routes. The total mileage of the railways of the United States is over 260,000; and there are over 26,000 miles of navigable rivers, with about 3,000 miles of canals.

Time Belts

Owing to the great extension of the United States across the meridians of longitude it has been found necessary to adopt four " Time Belts " having their times of noon one hour later as we pass from east to west. These belts are intersected by the following meridians of west longitude, which pass approximately midway along them: 75°, 90°, 105°, 120°. The times in these belts are known as " Eastern," " Central," " Mountain," and " Pacific " times respectively. C. J. S.

Photo: Sir H. H. Johnston.

BALES OF COTTON IN AN ALABAMA TOWN.

The alluvial plain of the lower Mississippi and the coastal plains of the Gulf and the Atlantic are the great cotton-growing regions of the United States which produce the bulk of the raw cotton used in the factories of the world.

Continued from page 433.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A.[Lond.]).

ALGEBRA.—XXIII

141. Binomial Theorem.

Consider the binomial $a + b$. We shall express $(a + b)^n$ in a series, assuming that n is a positive integer.

$(a + b)^n$ is a product of n factors, and each term of the resulting series must be formed by taking either a or b from each binomial factor $(a + b)$. Suppose b is taken from r of the binomial factors, then a must be taken from the $(n - r)$ remaining factors. This will give a term $a^{n-r}\, b^r$ which must be one term of the resulting series. The question is, how many times does this term occur ?

b was taken from r out of n binomial factors, and this can be done in as many ways as there are combinations of n things r at a time.

$\therefore$ the term occurs ${}_nC_r$ times, and hence ${}_nC_r\, a^{n-r}\, b^r$ is a term of the series.

If a be taken from all the n factors you get the term a^n, and if b be taken from all the n factors, you get the term b^n. This requires special notice, for if we put $r = 0$, then ${}_nC_r\, a^{n-r}\, b^r$ becomes ${}_nC_0\, a^n\, b^0 = {}_nC_0\, a^n$.

Now ${}_nC_0$ requires interpretation, for ${}_nC_0 = \frac{n!}{n!\ 0!} = \frac{1}{0!}$.

We assume, as before, that $\frac{1}{0!} = 1$.

Again, if we put $r = n$, we get the term ${}_nC_n\, a^0\, b^n = \frac{n!}{0!\ n!}\, b^n = \frac{1}{0!}\, b^n$, and once more we put $\frac{1}{0!} = 1$.

With this interpretation * we may write out the series as follows:

$$(a + b)^n = a^n + {}_nC_1\, a^{n-1}\, b^r + {}_nC_2\, a^{n-2}\, b^2 \ldots + {}_nC_r\, a^{n-r}\, b^r + \ldots\ldots + \ldots + {}_nC_{n-1}\, a\, b^{n-1} + b^n.$$

The series on the right is called the **expansion** of $(a + b)^n$.

* Unless we interpret $\frac{1}{0!}$ as 1, the general term ${}_nC_r\, a^{n-r}\, b^r$ does not include either the first or the last term of the series.

142. Proof by Induction.

It is easy to prove by actual multiplication that the theorem is true when $n = 2$ or $n = 3$

i.e. that $(a + b)^2 = a^2 + {}_2C_1\, ab + {}_2C_2\, b^2 = a^2 + 2ab + b^2$

and that $(a + b)^3 = a^3 + {}_3C_1\, a^2b + {}_3C_2\, ab^2 + {}_3C_3\, b^3 = a^3 + 3a^2\, b + 3ab^2 + b^3$

Now let us assume that the theorem is true for some particular value of n.

$$(a + b)^n = a^n + {}_nC_1\, a^{n-1}\, b + {}_nC_2\, a^{n-2}\, b^2 + \ldots + {}_nC_r\, a^{n-r}\, b^r + \ldots + {}_nC_{n-1}\, ab^{n-1} + b^n.$$

Multiply each side by $(a + b)$, then

$$(a + b)^{n+1} = (a^{n+1} + a^n\, b) + {}_nC_1\, (a^n\, b + a^{n-1}\, b^2) + {}_nC_2\, (a^{n-1}\, b^2 + a^{n-2}\, b^3) + \ldots\ldots$$
$$\ldots\ldots + {}_nC_{r-1}\, (a^{n-r+2}\, b^{r-1} + a^{n-r+1}\, b^r) + {}_nC_r\, (a^{n-r+1}\, b^r + a^{n-r}\, b^{r+1}) + \ldots\ldots$$
$$\ldots\ldots + {}_nC_{n-1}\, (a^2\, b^{n-1} + ab^n) + (ab^n + b^{n+1})$$

Collecting the like terms of the product, we get

$$(a + b)^{n+1} = a^{n+1} + (1 + {}_nC_1)\, a^n\, b + ({}_nC_1 + {}_nC_2)\, a^{n-1}\, b^2 + \ldots\ldots$$
$$\ldots\ldots + ({}_nC_{r-1} + {}_nC_r)\, a^{n-r+1}\, b^r + \ldots\ldots + ({}_nC_{n-1} + 1)\, ab^n + b^n.$$

Now $1 + {}_nC_1 = 1 + n = {}_{n+1}C_1$

and ${}_nC_1 + {}_nC_2 = n + \frac{n\,(n-1)}{1.2} = \frac{n\,(n+1)}{1.2} = {}_{n+1}C_2$

and in general, as we proved in the last lesson ${}_nC_{r-1} + {}_nC_r = {}_{n+1}C_r$.

Hence

$$(a + b)^{n+1} = a^{n+1} + {}_{n+1}C_1\, a^n b + {}_{n+1}C_2\, a^{n-1}\, b^2 + \ldots\ldots + {}_{n+1}C_r\, a^{n+1-r}\, b^r + \ldots\ldots\ldots + {}_{n+1}C_n\, ab^n + b^{n+1}.$$

Thus if the theorem be true for any value of n it will be true for the next greater value.

Now we know it is true when $n = 2$ $\therefore$ it is true when $n = 3$; and $\because$ it is true when $n = 3$ $\therefore$ it is true when $n = 4$; and so on. The theorem is therefore true for all positive integral values of n.

Examples:—

(1) Expand $(a + b)^6$

$$(a+b)^6 = a^6 + 6a^5b + \frac{6.5}{1.2}a^4b^2 + \frac{6.5.4}{1.2.3}a^3b^3 + \frac{6.5.4.3}{1.2.3.4}a^2b^4 + \frac{6.5.4.3.2}{1.2.3.4.5}ab^5 + \frac{6.5.4.3.2.1}{1.2.3.4.5.6}b^6$$

$$= a^6 + 6a^5b + 15a^4b^2 + 20a^3b^3 + 15a^2b^4 + 6ab^5 + b^6$$

(2) Expand $(a - b)^n$

$$(a-b)^n = [a + (-b)]^n = a^n + na^{n-1}(-b) + \frac{n(n-1)}{1.2}a^{n-2}(-b)^2 + \ldots\ldots + \frac{n!}{r!\,(n-r)!}a^{n-r}(-b)^r + \ldots\ldots + \frac{n!}{(n-1)!\,1}a(-b)^{n-1} + (-b)^n$$

$$= a^n - na^{n-1}b + \frac{n(n-1)}{1.2}a^{n-2}b^2 + \ldots\ldots + (-1)^r\frac{n!}{r!\,(n-r)!}a^{n-r}b^r + \ldots\ldots + (-1)^{n-1}\frac{n!}{(n-1)!\,1}ab^{n-1} + (-1)^n b^n$$

We have in the above written out the actual values of the coefficients, instead of using the forms ${}_nC_1$, etc. Clearly terms containing even powers of b will be positive, those containing odd powers of b will be negative.

(3) Expand $(3x - y)^4$

$$(3x-y)^4 = (3x)^4 + 4(3x)^3(-y) + \frac{4.3}{1.2}(3x)^2(-y)^2 + \frac{4.3.2}{1.2.3}(3x)(-y)^3 + \frac{4.3.2.1}{1.2.3.4}(-y)^4 = 81x^4 - 108x^3y + 54x^2y^2 - 12xy^3 + y^4$$

143. Let us denote the $(r + 1)$th term of the expansion of $(a + b)^n$ by T_{r+1}

Then $T_{r+1} = {}_nC_r\, a^{n-r}b^r$

To prove that coefficients of terms equidistant from the ends of the series are equal.

There are $(n + 1)$ terms in the expansion, and the sth term from the end is the $\{(n + 1) - (s - 1)\}$th term from the beginning. Hence the $(r + 1)$th term from the end is the $(n - r + 1)$th term from the beginning, i.e. is T_{n-r+1}

$T_{n-r+1} = {}_nC_{n-r}\, a^r b^{n-r}$

But ${}_nC_r = {}_nC_{n-r}$

And ${}_nC_r$ is the coefficient of the $(r + 1)$th term from the beginning.

Hence in the expansion of $(a + b)^n$, the coefficients of terms equidistant respectively from the beginning and the end of the series are equal.

144. Greatest Term of $(a + b)^n$

$T_{r-1} = {}_nC_r\, a^{n-r}b^r$, and $T_r = {}_nC_{r-1}\, a^{n-r+1}b^{r-1}$

$$\therefore \frac{T_{r+1}}{T_r} = \frac{{}_nC_r}{{}_nC_{r-1}}\frac{b}{a} = \frac{\frac{n!}{r!\,(n-r)!}}{\frac{n!}{(r-1)!\,(n-r+1)!}}\frac{b}{a} = \frac{\frac{(n-r+1)!}{(n-r)!}}{\frac{r!}{(r-1)!}}\frac{b}{a} = \frac{n-r+1}{r}\frac{b}{a}$$

$$\therefore T_{r+1} = T_r \times \frac{n-r+1}{r}\frac{b}{a}$$

As long as $\frac{n-r+1}{r}\cdot\frac{b}{a}$ is numerically greater than 1 $T_{r+1} > T_r$.

We will deal only with the *numerical* increase in value of the terms, and therefore if b and a have opposite signs, we shall treat them as if they had the same signs,

i.e. we shall consider only the positive quantity $\frac{b}{a}$ where b and a are both taken as positive.

Then $T_{r+1} > T_r$ if $\frac{n-r+1}{r}\cdot\frac{b}{a} > 1$

i.e. $b(n - r + 1) > ar$

i.e. $b(n + 1) > (a + b)r$

i.e. $\frac{b(n+1)}{a+b} > r$

Thus $T_{r+1} \gtreqless T_r$ according as $\frac{b(n+1)}{a+b} \gtreqless r$

Example:—

Find the greatest term in the expansion of $(5 + 2)^9$

$$\frac{T_{r+1}}{T_r} = \frac{n-r+1}{r}\cdot\frac{b}{a} = \frac{9-r+1}{r}\cdot\frac{2}{5} = \frac{2(10-r)}{5r}$$

$T_{r+1} \gtreqless T_r$ according as $2(10 - r) \gtreqless 5r$

i.e. $20 \gtreqless 7r$, i.e. $\frac{20}{7} \gtreqless r$

Thus $T_{r+1} > T_r$ when $r < 3$

Hence we have

$T_1 < T_2 < T_3 > T_4 > T_5 > T_6 > T_7 > T_8 > T_9 > T_{10}$

i.e. T_3 is the greatest term.

The **greatest coefficient** of a binomial expansion can be found in a similar manner.

Coefficient of $T_{r+1} = \frac{n-r+1}{r} \times$ coefficient of T_r

$\therefore$ coefficient of $T_{r+1} \gtreqless$ coefficient of T_r according as $\frac{n-r+1}{r} \gtreqless 1$

i.e. as $\frac{n+1}{2} \gtreqless r$

Examples:—

(1) In $(a + b)^6$ the coefficient of the 4th term is the greatest.

(2) In $(a + b)^7$ the coefficients of the 4th and 5th terms are equal and are greater than the coefficients of any of the other terms.

Exercise 34

Write out the following expansions:

(1) $(a - x)^7$. (2) $(2a - x)^5$. (3) $(1 - x^2)^4$. (4) $(x^2 + 2y^3)^5$.

(5) $(2x + \frac{y}{2})^4$. (6) $(a - \frac{3}{b})^7$.

(7) Find the 6th term of $(2 - y)^8$.

(8) Find the 21st term of $(2 - b)^{22}$.

(9) Find the general term of $(a + 2b)^n$.

(10) Find the general term of $(2a - 3b)^n$.

(11) Find the middle term of $(1 + x)^6$.

(12) Find the term of $(a + b)^{24}$ which has the greatest coefficient.

M. A. L.

GEOMETRY.—XXI

Proposition 146.—Problem

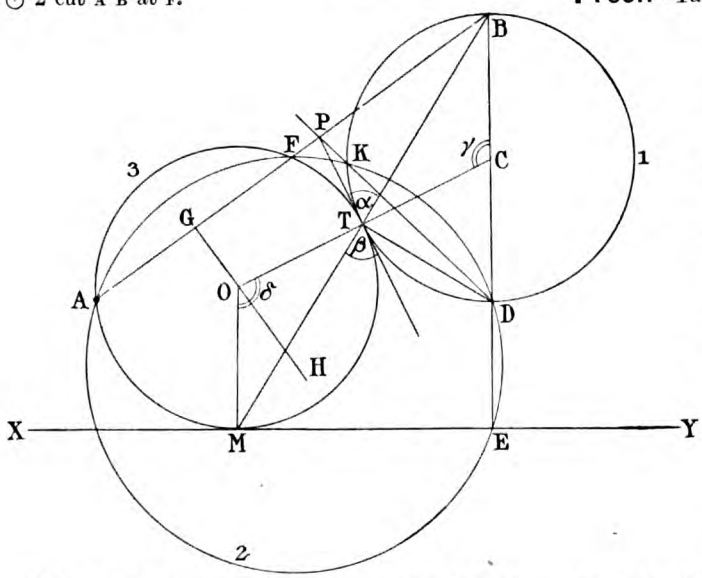
To describe a circle passing through a given point and touching a given circle and a given straight line.

Let A be the given pt., X Y the given str. line, and 1 the given ⊙ having centre C.

Draw diameter B C D of ⊙ 1 ⊥ to X Y and let it cut X Y at E.

Join A B.

Describe ⊙ 2 passing through A, D and E and let ⊙ 2 cut A B at F.



Let D K, the common chord of ⊙s 1 and 2 when produced cut A B at P.

Draw P T tangent to ⊙ 1.

Join C T and let it cut the ⊥ bisector, G H of A F at O.

With centre O and radius O T describe ⊙ 3. This is the required ⊙.

Proof.—⊙ 3 passes through A F and touches ⊙ 1 at T (Prop 145).

Join B T and produce it to cut X Y at M.

Join T D.

∠ B T D is a rt. ∠ (∠ in a semi ⊙).

∴ ∠ D T M is a rt. ∠.

Also ∠ D E M is a rt. ∠.

∴ T, D, E and M are concyclic (Prop. 69).

∴ rect. B T . B M = rect. B D . B E (Prop. 121).

But rect. B F . B A = rect. B D . B E (secants of ⊙ 2) (Prop. 121).

∴ rect. B F . B A = rect. B T . B M.

∴ T, M, A, F are concyclic.

And ⊙ 3 passes through T, F and A ∴ ⊙ 3 passes through M.

Join O M.

α = ∠ in alt. segment T D B of ⊙ 1.

= ½ γ.

β = ∠ in alt. segment T A M of ⊙ 3.

= ½ δ.

But α = vert. opp. ∠ β ∴ δ = γ ∴ O M is ‖ to B C.

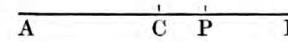
But B C is ⊥ to X Y ∴ O M is ⊥ to X Y.

∴ ⊙ 3 touches X Y at M.

Proposition 147.—Problem

To divide a given straight line internally so that the rectangle contained by the two segments may be the greatest possible.

Let A B be the given str. line.



Bisect A B at C.

Then C is required pt.

Proof.—Take any other pt. P in A B.

Rect. A P . P B = A C² − C P² (Prop. 97).

Now A C is constant.

∴ rect. A P . P B is greatest when C P is least.

i.e. when C P = 0, that is when P coincides with C.

∴ rect. A C . C B = A C² is greatest possible rect. contained by the segments.

Proposition 148.—Problem

If A and B be fixed points on the same side of a fixed straight line X Y. To find a point P in X Y such that the sum of A P and B P may be the least possible.

Draw A C ⊥ to X Y and produce it making C D = C A.

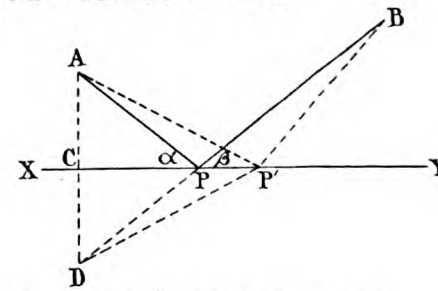
Join D B cutting X Y at P.

P is the required pt.

Proof.—Take any other pt. P′ in X Y.

Join P′ to A, B and D.

X Y is the locus of pts. equidistant from A and D. i.e. P A = P D and P′ A = P′ D.



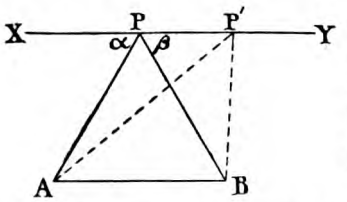
∴ P A + P B = P D + P B = B D and P′ A + P′ B = P′ D + P′ B.

Now P′ D + P′ B > B D (Prop. 12).
∴ P′ A + P′ B > P A + P B.

NOTE.—The above construction is the same as that used in Prop. 54 to find P such that α may = β.

Proposition 149.—Problem

If the base and area of a triangle be given, to find the position of its vertex which will make the sum of its sides the least possible.

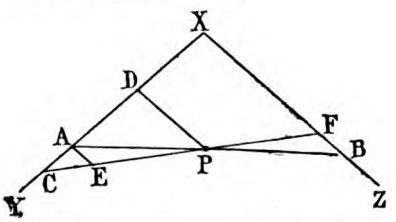


Let A B be the given base.
Then ∵ area is fixed the locus of P is a str. line ‖ to A B at a fixed distance from it.
The sum of A P and B P is least when α = β (Prop. 147 Note).
But if α = β then ∠ P A B = ∠ P B A (alt. ∠s) (Prop. 26).
∴ △ P A B is isos. (Prop. 7).

Proposition 150.—Problem

Through a given point to draw a line which shall form with two given intersecting two straight lines, a triangle of minimum area.

Let P be the given pt. and X Y, X Z the given str. lines.
Through P draw a line ‖ to X Z cutting X Y in D.
From D Y cut off D A = D X. Join A P and produce to cut X Z in B.
Then A B is the required line.



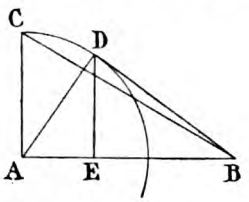
Proof.—Let C E F be any other line through P.
Draw A E ‖ to D P.
Then ∵ A D = D X ∴ A P = P B
in △s A P E, B P F.
A P = B P.
∠ A P E = ∠ B P F (vert. opp).
∠ P A E = ∠ P B F (alt.).
∴ △ A P E = △ B P F (Prop. 9).
Add to each the fig. A P F X
Then fig. A E F X = △ A B X.
Now △ C F X = fig. A E F X + △ A C E
∴ △ C F X > fig. A E F X
i.e. > △ A B X.

Corollary.—*The line through the point P which cuts off the minimum triangle, is bisected at P.*

Proposition 151.—Theorem

When two sides of a triangle are given in magnitude, the area is a maximum when they contain a right angle.

Let A B, A C be the sides given in magnitude.
Let the ∠ at A be a rt. ∠.
With centre A and radius A C describe a ○.
Take any other pt. D on the circumference.



Draw D E ⊥ to A B.
Then A D > D E (opp. rt. ∠).
∴ A C > D E.
Since base A B is common, and height of △ A C B > height of △ A D B,
∴ △ A C B > △ A D B.

Exercise 24

(1) On each side of a parallelogram as hypotenuse an isosceles right-angled triangle is drawn **outwards** and the outer vertices of these triangles are joined. Prove that the resulting quadrilateral is a square.

(2) Show how without using a protractor to inscribe an equilateral triangle in a given circle, with one of its vertices at a given point in the circumference of the circle.
Show that its altitude is three-quarters of the diameter of the circle.

(3) Show how to draw two tangents to a given circle so as to contain a given angle.

(4) Two parallel straight lines are cut by a transversal in the points A, B, and two circles are drawn each touching the three straight lines. Prove that the distance between their centres is equal to A B.

(5) Show how to find a point C on a straight line A B, such that $A C^2 = A B \cdot C B$; and prove that $A B^2 + C B^2 = 3 A C^2$.

(6) If D is the mid-point of the base B C of a triangle A B C, prove that $A B^2 + A C^2 = 2 A D^2 + 2 D C^2$.
Given two points B, C, on the same side of a given straight line, find a point P on the straight line such that $P B^2 + P C^2$ is as small as possible.

(7) A B is a straight line divided internally at C. Show how to draw through C a line so that the square of the perpendicular upon it from A may be equal to the rectangle A B . B C.
When is this impossible?

(8) Prove that if A, B are two given points, and k a given length less than A B, the locus of a point P which moves so that $A P^2 - B P^2 = k^2$ is a straight line perpendicular to A B; and also that, if a circle is drawn with centre A and radius k, the locus bisects the tangents drawn from B to this circle.

(9) If a quadrilateral can be divided by a straight line crossing it, so that circles can be inscribed in each of the two quadrilaterals into which it is divided, show that the length of the straight line is half the excess of the sum of the one pair of opposite sides of the quadrilateral over the sum of the other pair.

(10) A, B, C, D are four points on a circle such that the chords A C, B D intersect at right angles inside the circle. Prove that the tangents at A, B, C, D form a quadrilateral which can be inscribed in a circle.

(11) Draw an equilateral octagon with each of its eight sides distant 1·5 inch from a given point.

(12) In the acute-angled triangle A B C the bisector of the angle A and the perpendicular from A on B C meet the circum-circle at L, M respectively. Prove that the arc L M is equal to half the difference of the arcs A B, A C. (Each arc is supposed to be less than half the circumference.)

(Questions 1–12 are from the London Matric. Exam.) M. A. L.

SPECIAL SUBJECTS

No. 4.—THE STORY OF OUR FOOD SUPPLY

LOOKING back to the earliest ages, it will be found that foodstuffs invariably formed the basis of trade and bartering.

A piece of land of a certain area will produce food for the needs of a given number of people and no more. When there is an excess of human beings dwelling on a piece of ground they must naturally import their sustenance from elsewhere. And, with this exchange of the fruits of labour for food, we have the story of commerce told in a nutshell.

According to some authorities, estimates have been prepared that prove that the earth's surface can be made to grow foodstuffs of sufficient quantity to maintain 6,000 millions of people. At the present time the estimated population of the world is less than 2,000 millions; so that the day when we may not have a large enough area upon which to raise the food required is as yet far distant, even should the present ratio of increase be maintained.

Primeval and Modern States

But, to explain more fully the fact that countries with crowded populations must depend more and more upon sparsely occupied lands for the augmentation of their food supply, it may be pointed out that whereas in the United Kingdom there are nearly 400 people to the square mile, in the United States of America (the greatest wheat producing country in the world) there are but thirty people settled on the square mile.

Thus, countries with the densest populations (Belgium carries nearly 700 people to the square mile) must necessarily import food from those that are but thinly filled. Both Canada and Australia can boast of only two persons to the square mile of their territory. New Zealand has eleven people; South Africa thirteen; whilst India has 158.

Taking this line of reasoning as the bedrock of the food question, therefore, it will be seen that to feed the 400 people who crowd together on every square mile of the United Kingdom the product of their handicraft must be sent overseas to pay for their sustenance. Man must work in order to eat and live.

In a primeval state every man grew sufficient food for the needs of his family and himself. In these times of civilisation he must barter a portion of his work for food.

John Bull—Farmer

Broadly speaking, there are in Great Britain some thirty-two millions of acres of ground cultivated; and of this area more than half is down to permanent pasture. About one-sixth of the entire area produces hay.

Thus some fifty per cent. of our available land is utilised for the feeding of animals, beasts of burden, milch cows, and stock for the butcher on grasses alone. (*See* Plate facing p. 441.)

We will suppose, therefore, that Great Britain farms one enormous field, for the sake of argument, rectangular in shape. We divide it into half showing permanent pasture and land set aside for hay. The other half consists approximately of fifteen millions of acres, and this we may subdivide as follows:—

Two millions for Wheat.
Two millions for Barley.
Three millions for Oats.
One million for Beans, Peas, and Rye.
Three millions for Potatoes, Turnips, Mangolds and Cabbage.

We have thus accounted for eleven millions of acres, and the four millions that remain may be divided in half again: two millions going to the cultivation of clover and similar grasses, and the remainder to hops, small fruit (gooseberries, currants, raspberries, etc.) orchards and flax.

Now so far as the stock of this large farm is concerned there are approximately one and a half millions of horses, made up of animals used solely for agriculture; breeding mares and unbroken horses. Of cattle of all sorts there are about seven millions; of sheep

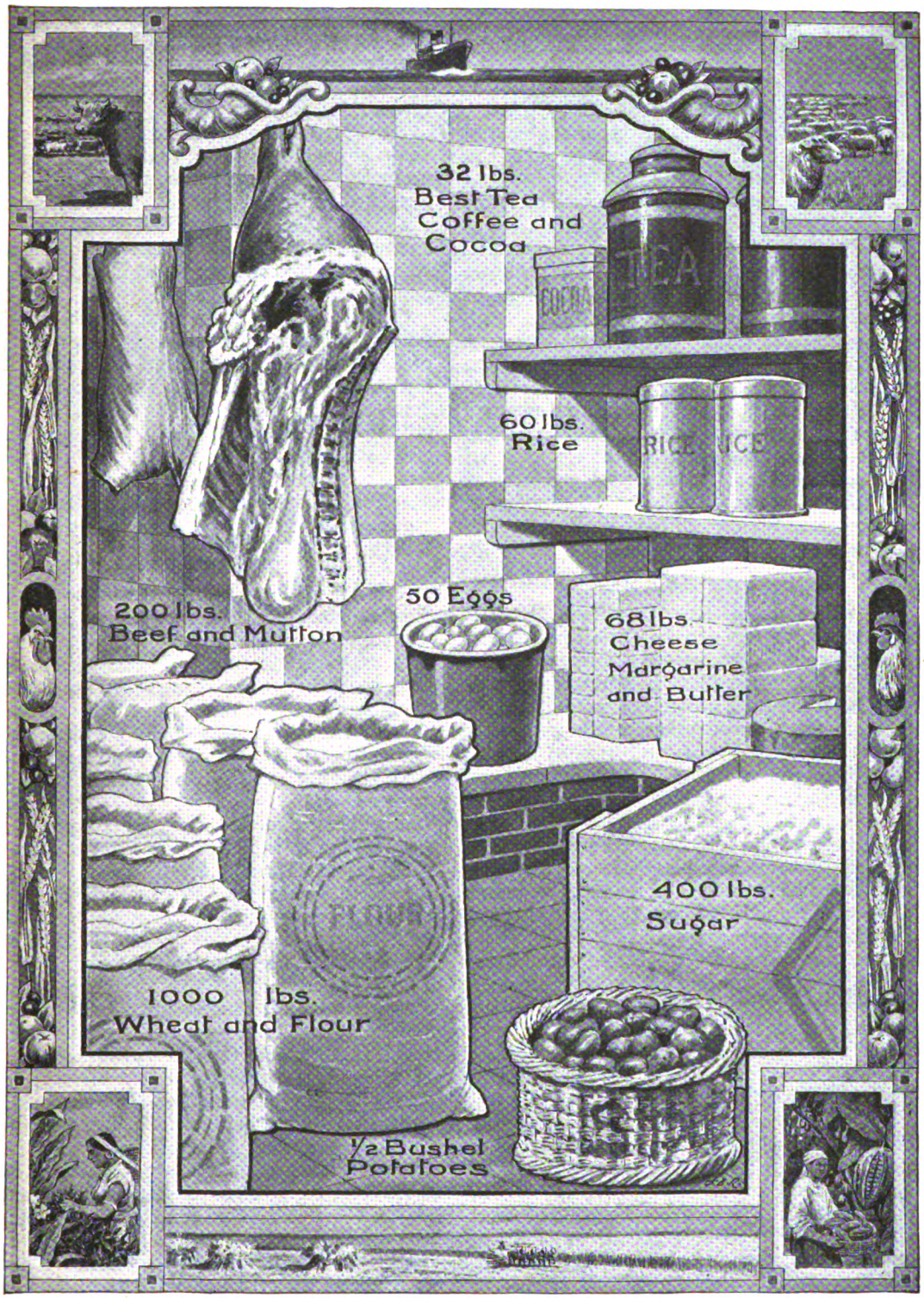


Chart showing the amount of imported food consumed annually in the average small British household, consisting of father, mother and two children. The foodstuffs shown all come from overseas, and are strictly in addition to any home-grown commodities the family may consume.

twenty-four millions, and of pigs about two millions.

So much, therefore, for our efforts at the production of foodstuffs at home. As to how far this food goes towards our sustenance as a nation the figures of our imports can best show.

Thus, in a recent year, we raised at home about fifty-five million bushels of wheat. Yet the wheat we bought abroad actually cost us 84½ million pounds sterling. Of oats we grew over 100 million bushels, yet bought supplies worth nearly twelve millions. And on grain and flour alone from overseas we spent the colossal sum of 175 million pounds!

Then again, despite the stock on our own farms, we spent more than 100 millions upon meat—bacon, beef, mutton and pork. Of butter and cheese (both staple products of British agriculture) we imported supplies to the value of twenty millions sterling in each commodity.

Imported Food

It will thus be seen to what a limited extent the nation can be described as self-supporting and how meagre our own resources are in food production in comparison with the daily demands of the national larder.

And one of the surprises of the importing statistics is that we actually spend beyond our own shores more than six millions annually upon vegetables alone; whilst we buy more than eight million pounds' worth of fruit. It is certainly anomalous that growers abroad can place the products of market gardens upon our markets at prices that compete successfully with those charged for the home-grown article.

And now, in order to obtain the clearest possible understanding of exactly how dependent we are upon supplies from overseas, we will imagine a small family consisting of father, mother and two children, and calculate precisely what, as a family, they consume in imported supplies in one year.

First of all, assuming them to be the equal of the average family, they will require more than 1,000 lb. of wheat and flour; 200 lb. of beef, mutton, and other imported meat; more than half a bushel of potatoes from abroad; nearly 400 lb. of sugar; 68 lb. of butter, margarine and cheese; 32 lb. of tea, coffee or cocoa; and about 60 lb. of rice.

And all these foodstuffs will have come from overseas and be strictly in addition to any home-grown commodities the small family may consume! As to the actual money value of the food so purchased from abroad the housekeeping bill from this family would carry rather over £10 per head for the year to be spent on nothing but imported food.

At the same time, it must not be supposed that the whole of the 450 millions we spend annually on imported food goes into the hands of foreigners, for this is by no means the case. Of our imports of wheat, for example, we obtain about one-half from the British Empire overseas and in the case of flour more than two-thirds.

Canada supplies us with about twenty millions of cwts. annually of grain; India with three million cwts., and Australia with ten million cwts., and so far as meal and flour are concerned we buy nearly eight million cwts. from the British Empire and ten million cwts. from foreign countries. As a matter of fact, the United States of America sells to us more wheat than any other country.

Interdependence of Nations

And now it may be interesting to take a peep at other importing countries in which the population per square mile is so great that they are unable to make themselves self-supporting. In a recent year the United Kingdom imported more than twenty millions of quarters of wheat (480 lb. per quarter); France and Italy ten millions each; Belgium three millions; and Holland two millions of quarters.

It will thus be seen that the countries of the Old World (with the exception, of course, of illimitable Russia) are to a great extent dependent upon the New World for the means of sustenance.

In the production of wheat the United States of America heads the world, with Russia second and India third; more barley is grown in Russia than in any other country, with the U.S.A. second and India third; the U.S.A. heads the list with oats and maize, and Russia with rye.

It will thus be seen how one nation is dependent upon others for food, and also how in the scheme of international commerce a country that is sparsely populated gives of its food supplies in exchange for manufactured articles that come from thickly inhabited countries. The natural conditions which make food growing upon a colossal scale possible are primarily responsible for this state of things, and prices of foodstuffs to the consumer are dependent solely upon the world's supplies available, so intermingled are the relations of the nations one with another.

Continued from page 440.

BUSINESS AND COMMERCE:

***Contributors*:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).**

COMMERCIAL TRAINING.—XXII

In many cases, with wholesale firms in close proximity to a port, goods would be dispatched by ship, sea transit being proportionately slower, but far cheaper, than the rail.

In dispatching goods by steamer, it is necessary for the dispatch clerk to obtain the rates of carriage, or "freightage," as it is generally known. All round our coasts a regular service of "coastwise" steamers is maintained, and the clerk should know the days of sailing, the wharves at which the steamers lay, and similar details. He should be able to arrange when necessary for a cartage contractor to call and fetch the goods from the warehouse, and also understand bills of lading and shipping documents.

Canal and Lorry Transport

Or again, the goods may be dispatched by road in lorries or steam wagons, in which event there will be parcel books to make up. As another alternative, the articles may be dispatched by canal. In Great Britain there are hundreds of miles of canals and inland waterways that bear an immense amount of our home commerce with less fear of breakage than by rail; and generally speaking, at far lower rates.

We may imagine, however, that the goods have been dispatched by one or other of these ways. In either case, the dispatch clerk will have entered details of the consignment in his Delivery Book, and will furnish particulars to the ledger clerk, who will check the various items by the order as received from the commercial traveller.

In some circumstances a formal notification is posted that the goods have been dispatched; but, generally speaking, the consignee first receives his invoice by post and accepts this as an intimation that the goods are on the way to him.

The invoice will set out the nature of the goods, their price, discounts allowable, terms upon which the goods are sold, and in most instances the route by which they have been consigned. Upon the arrival of the goods thay are checked and examined by the details of this invoice, and in the event of any discrepancy it is immediately reported to the wholesaler.

But the work of the wholesale merchant is not concerned only with the sale of goods, and the clerk who would make his way through the various stages of the business must be prepared to understand buying quite as much as he does selling.

Practically speaking, the wholesaler and the retailer are the middlemen betwixt the producer and the consumer. The retailer is in close, personal touch with the consumer, and is able to inform the commercial traveller from his wholesale house precisely the trend of the trade, for no industry stands still and there are always almost imperceptible changes taking place.

Developing Markets

And, just as the retailer forms a *liaison* with the consumer, so must the wholesaler work closely with the producer, acquainting him with the needs of the market, inspiring new ideas and developments, and freely offering suggestions as to the type of article required. This work forms the chief duty of the buyer, who will move about in the producing centres, keeping closely in touch with the trade in which he is interested, so that he may be always prepared to buy to the best advantage. Periodically there will be meetings between principals, buyers and commercial travellers, at which the many aspects of the trade will be closely discussed.

On the other hand, of course, there are many wholesale houses that are also producers; and in this case the commercial travellers will pay frequent visits to the

works so that they may be always well informed as to the goods the firm is manufacturing; they will moreover be able to examine all the improvements which an enterprising house adopts from time to time.

But the widening of the influence of a wholesale house is not dependent entirely upon the commercial traveller. Most wholesale firms rely to some extent upon the efforts of a publicity manager, who arranges that their goods shall be widely advertised in the leading trade journals; and these journals form a most vital link between the wholesaler and the retailer.

Advertising

But in many instances there must also be publicity among the general public, and this is ensured by the provision of an Advertising Department, often working largely in connection with the staff of commercial travellers. Advertisements in leading newspapers play no small part in bringing goods to the notice of readers. Some business men aim indeed not only at supplying public wants, but creating new demands.

In this section there is much scope for the wholesale clerk with ideas, and the advertising profession offers many opportunities to the man or woman with individual ideas.

Again, the wholesaler and his staff must not be content merely to sell such goods as are in present demand. It is mainly through the wholesale firms that new goods are introduced, new types, fresh designs, cheaper and better lines, and all that counts towards advancement in the particular trade. The wholesalers, therefore, compete among themselves, not only to cut prices, but also to produce or market the very latest ideas in their own particular trade or section.

Generally speaking, a wholesale merchant makes a lower profit upon an individual article than does the retailer, but the former naturally enjoys a far greater turnover proportionately.

At the same time, the pure routine of the wholesale business is very much akin to that of the retail, except that goods are dealt with in larger bulk and in more commodious warehouses with a different type of staff.

Such matters as stock-keeping and stock-taking, though, run on very similar lines, and, with other aspects of commerce, will be dealt with next. A. B.

CHOOSING A CAREER.—XXIV

The Stage.—As a career the stage is only for those of exceptional natural ability, and is not a profession to be lightly recommended.

However, for those who are determined upon entering this profession and making it a career, one of the best plans of all is to join an amateur dramatic or operatic company. Such companies or societies exist in most towns and are useful for the development of any latent talent the aspirant may possess. The existence of real ability should be actually proven either in this way or by submission to a professional actor or manager capable of giving a definite opinion of talent. With such an assurance the candidate may take a course of training at one of the schools of dramatic art, where the rudiments of drama and elocution or of stage dancing are taught. As a general rule the fees at these academies are not exorbitant. There are several such places in London, and a few at other great centres in the country.

Another plan, for those who cannot afford either the time or the fees for tuition, is to obtain some minor part in a play and to become "walkers-on." Only a trifle may be earned per night, but the experience should prove useful, and may eventually lead to a small speaking part.

In the chorus of *musical comedy* there is an opening for both men and women, but the wages paid are usually small.

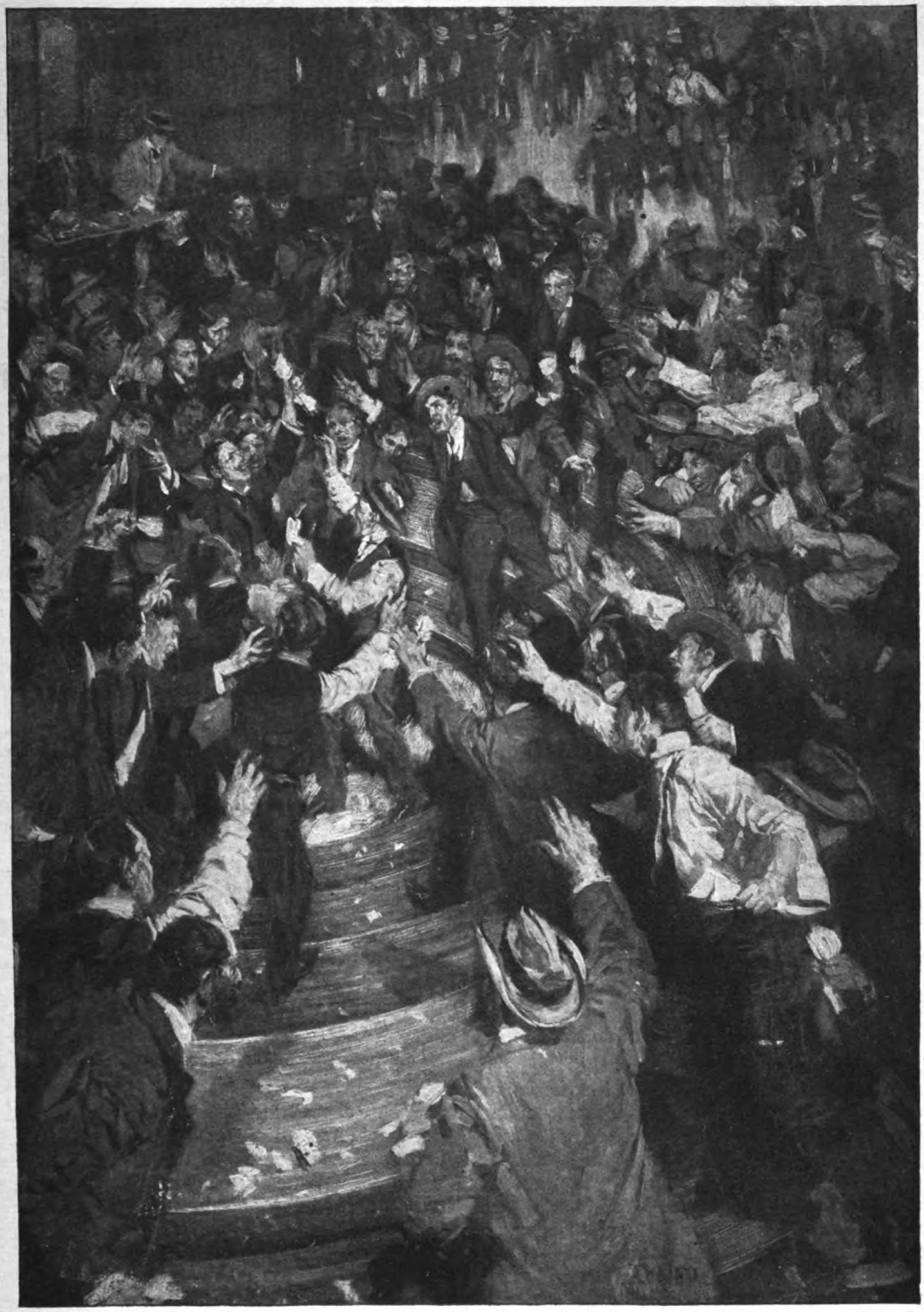
To enter a chorus the usual plan is to obtain first of all an introduction to a theatrical agent, who will suggest the type of "business" most likely to suit the applicant. The agent will then arrange for the beginner to attend a voice trial.

So far as the *music halls* are concerned, very much the same rules pertain, except that the individual performer must necessarily stand even more upon his own particular merits.

To obtain a post upon the staff of a *cinema acting* company the applicant should have made a close study of film matters, and should clearly understand that a totally unique style of acting and impersonation is required.

The candidate should then write to the head offices of some of the film-producing companies, and should ask for the opportunity of appearing either in "crowds," or in small parts at the performances where films are made.

The addresses of the film producing



THE WHEAT PIT AT CHICAGO.

A busy scene at one of the wildest speculative centres in the world, the Exchange where wheat "futures" are bought and sold, and where fortunes are made and lost in a few hours.

companies may be obtained from a copy of one of the cinematograph trade journals, obtainable to order through any newsagent.

Society entertainers, conjurers, marionette and Punch and Judy performers who visit large private houses for the amusement of parties of guests must naturally be men and women of exceptional ability and individuality. Starting in a small way, they will build up for themselves a connection or clientèle; but with this class of professional people it is usual to do business through a firm of agents, such as Messrs. Keith, Prowse & Co., of London, who will obtain them their engagements upon the commission basis.

Lecturing forms another outlet for the person who can speak well and grip the attention of an audience. Clergymen, schoolmasters and other gentlemen of education frequently obtain spare-time engagements to deliver lectures; and the various political organisations employ paid lecturers.

A fee of from one to five guineas may be obtained by the lecturer in addition to his out-of-pocket expenses.

Travellers and scientific men frequently adopt lecturing as a side line, and may receive from one to ten guineas per lecture, with expenses. A. C. M.

BOOK-KEEPING.—XVIII

CONTINUING our study of Contract Accounts, it may be pointed out that when a contract has been completely fulfilled, and all the instalments have been received, and credited, the difference between the two sides of the Contract Account will represent either a profit or a loss. If the debit side is the greater, a loss has been incurred; whilst if the credit side is the greater, the balance represents a gain.

Uncompleted Contracts

It frequently happens that at the time when it is desired to close the books of account, a contract may be completed, but there is a balance due to the contractor. In order that the profit or loss of such a contract may be ascertained, the amount due is entered as if received, and at the same time a corresponding debit entry is made to the Personal Account of the person or firm from whom the amount is due. That is to say, the Contract Account is closed, and the amount due is transferred to the debtor's Personal Account.

A somewhat more difficult case, however, is presented where a contract is not completed at the time of closing the books. Some firms prefer to leave out all consideration of profit until a contract is fully completed. Others, however, favour the method of estimating the profit on the amount of work actually done. Under normal conditions, the latter one is to be preferred. If such profit or loss is not estimated, the true position will not be shown in the completed accounts. This method tends to keep the profits or losses nearer to the periods to which they relate.

Contract Accounts

We will now consider three of the four contracts mentioned in the last lesson, and show the Contract Accounts for the transactions which have taken place.

Contract No. 150 was accepted for £10,000.
" " 250 " " " £4,500.
" " 300 " " " £7,000.

RE CONTRACT NO. 150

General expenditure	£6,000
Materials supplied	£600
Wages paid	£500
Instalments received on account	£2,000
" " " "	£4,000
" " " "	£3,000
" " " "	£1,000

Contract fully completed, and all money paid.

RE CONTRACT NO. 250

General expenditure	£3,000
Materials supplied	£300
Wages paid	£200
Instalments received on account	£1,000
" " " "	£500
" " " "	£2,000

Contract completed, but £1,000 due not yet paid by J. Ellis and Phillips.

CONTRACT NO. 300

General expenditure	£4,500
Materials supplied	£1,400
Wages paid	£100
Instalments received on account	£2,000
" " " "	£2,000
" " " "	£1,000

Contract not completed, but profit estimated is £500.

When a contract is quite completed, the Contract Account is closed, and the profit or loss is transferred to the Profit and Loss Account. When a contract is not completed, the difference between the value of labour and materials and the amount of instalments received will represent an asset or a liability, and it is desirable that the totals of costs and receipts should be shown in the Balance Sheet thus :—

ASSETS

CONTRACT NO. 300

Labour and Materials	£6,000	
Less Instalments received	£5,000	£1,000

CONTRACT NO. 150

	£	s.	d.		£	s.	d.
To General expenditure	6,000	–	–	By Cash on A/c	2,000	–	–
„ Materials	600	–	–	„ „ „ „	4,000	–	–
„ Wages	500	–	–	„ „ „ „	3,000	–	–
„ Profit and Loss A/c	2,900	–	–	„ „ „ „	1,000	–	–
	£10,000	–	–		£10,000	–	–

CONTRACT NO. 250

	£	s.	d.		£	s.	d.
To General expenditure	3,000	–	–	By Cash	1,000	–	–
„ Materials	300	–	–	„ „	500	–	–
„ Wages	200	–	–	„ „	2,000	–	–
„ Profit and Loss A/c	1,000	–	–	„ J. Ellis and Phillips	1,000	–	–
	£4,500	–	–		£4,500	–	–

CONTRACT NO. 300

	£	s.	d.		£	s.	d.
To General expenditure	4,500	–	–	By Cash	2,000	–	–
„ Materials	1,400	–	–	„ „	2,000	–	–
„ Wages	100	–	–	„ „	1,000	–	–
„ Estimated profit (P. and L. A/c) ..	500	–	–	„ Balance .. .. .. c.f.	1,500	–	–
	£6,500	–	–		£6,500	–	–
To Balance	c.f. £1,500	–	–				

The student will remember that in our last lesson we explained that Plant was something which was used on a contract, but which was not put into the actual structure of the building. It frequently happens that when a contract is completed, some of the plant which has been used is disposed of. It is very unusual for such plant to realise its original cost, as having been in use for some time, it must necessarily have depreciated in value. Whatever loss is incurred has clearly been brought about by the contract concerned, so that the account for such contract must be debited. Suppose, for example, that you have sold a jib crane, which has been used on contract No. 200, and that the crane realised £50 less than the amount it cost when it was placed on the job. This £50 must be placed to the debit of the account for contract No. 200, and will be journalised thus :—

Contract No. 200	Dr. £50	
To Plant Account		£50
Loss on sale of jib crane.		

Jobbing Account

For small sundry jobs, such as repairing a wall, adjusting a small drain, etc., it is usual to open a Jobbing Account. This Account is credited, and the person for whom the work is done is debited.

In the building trade, the question of extras is generally an extremely complicated and a very vexed one, which often causes long and heated discussions between architects and contractors. Although architects prepare complete drawings, showing all the work required, and furnish in addition detailed particulars describing the nature and extent of the labour and materials necessary for a given contract, it is very seldom that every possible contingency is covered.

Retention Money

It frequently happens that many "extras" are required. For these the Contractor must make an extra charge. It is usual when such extras are charged for particulars to be worked out in minute detail, all labour and materials being shown separately. When this is the case, it is looked upon as day work, and a fresh number is given to each extra job. Theoretically all extras are added to the contract, but in practice each extra is debited to the Personal Account, but kept separate from the Contract Account.

Another matter which must be mentioned in connection with contracts is Retention Money. This is a portion, usually a percentage, of the contract amount which the architect keeps back from the Contractor until a certain period has elapsed after the job is completed. This is done so that if the work is in any way defective, it may be made good by the Contractor before the Contract Account is actually closed. This Retention Money is dealt with in the same way as money due on a completed contract.

The affairs of Arthur Abel, Contractor, stood as follows on January 1st :—

Assets.	£	s.	d.
Cash in Office	30	–	–
„ at Bank	900	–	–
Bills Receivable, No. 1	200	–	–
„ „ No. 2	240	–	–
Benjamin Binns	720	–	–
Expenditure on Contract 10	2,160	–	–
„ „ 11	4,800	–	–
Freehold Premises	7,500	–	–
Horses and Carts	1,100	–	–
Stock of Materials	3,000	–	–

Liabilities.	£	s.	d.
Bills Payable, No. 20	150	–	–
„ „ No. 21	150	–	–
Charles Cain	350	–	–
Instalments received on Contract 10	1,200	–	–
„ „ „ 11	3,600	–	–

His transactions for the month are given below. You are requested to enter them in the proper books, post them to the Ledger, make out a Trial Balance, Profit and Loss Account, and Balance Sheet. Closing entries should be passed through the Journal. All payments, unless otherwise stated, are made by cheque; all receipts are paid into the Bank same day.

		£	s.	d.
Jan. 1	Received Cheque for Bill No. 1	198	10	–
	Rebate allowed	1	10	–
	Signed Contract 12 to restore St. John's Church for	4,000	–	–
2	Bought of Charles Cain, Bricks value	530	10	6
	Paid him Cheque	350	–	–
	And Acceptance at 3 months	300	–	–
4	Paid for two new Horses	75	–	–
	„ „ Postages, etc.—Office Cash	2	12	6
5	Received Instalment on Contract 11	615	–	–
6	Paid Wages—Contract 10	155	15	–
	„ „ — „ 11	90	5	–
7	Materials supplied to Contract 10	365	10	–
	„ „ „ 11	550	10	–
	„ „ „ 12	240	15	–
8	Retired Acceptance No. 20 for Cheque	148	12	6
	And Rebate	1	7	6
9	Bought Tiles of Charles Cain for 2 months' Bill	230	17	6
11	Received Cheque from Benjamin Binns	411	12	–
	Discount in addition	8	8	–
	Paid for Repairs to Carts	10	5	6
12	Bill Receivable No. 2, Frank Fox, £240, due this day, returned dishonoured.			
	Noting Expenses—Office Cash	–	12	6
13	Retired Acceptance No. 21, Cheque	247	10	–
	Rebate allowed	2	10	–
14	Arthur Abel's Drawings	45	–	–
	Charge Benjamin Binns for Repairing his Roof	12	2	6
15	Bought Cement of Charles Cain	290	10	6
16	Paid Wages—Contract 10	60	–	–
	„ „ — „ 11	100	14	6
	„ „ — „ 12	45	7	6
	„ „ Yard Watchman—Office Cash	1	15	6
18	Materials supplied to Contract 10	605	–	–
19	Received Instalment Contract 10	720	–	–
20	Paid for Water to Contract 11	5	10	–
	Materials supplied to Contract 12	175	2	–
21	Wrote off value of a Horse killed in street	35	–	–
22	Received of Edward Easton for Cartage	20	5	9
23	Contract 10 completed and passed. Final instalment received	2,400	–	–
25	Contract 11 completed. Balance due	1,200	–	–
26	Received Instalment on Contract 12	150	–	–
27	Received Cheque for Frank Fox's dishonoured Bill and Noting Expenses			
28	Received Instalment on Contract 11	600	–	–
30	Paid Salaries	80	–	–
31	Interest on Capital	54	–	–
	Depreciation of Premises	10	–	–
	Stock of Materials on hand	2,200	–	–

Answer :—

Profit on Materials, £84 19s. ; Profit on Contract No.10, £973 15s. ; Profit on Jobbing Account, £32 8s. 3d. ; Loss on Contract No. 11, £131 19s. 6d. ; Net Profit, £759 8s. 9d. Total of Balance Sheet, £16,920 7s. 3d.

(National Union of Teachers.) F. H.

SHORTHAND.—XII

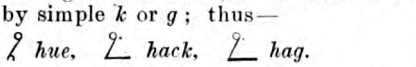
Key to Exercise 42

1. equip, squib, sequel, squally, quire, inquire, request, inquest.
2. lingual, linguist, somewhere, anywhere, nowhere, everywhere, queer.
3. Welsh, wealthy, meanwhile, whale, shearer, snorer, kneeler, feeler.
4. stamps, romp, jumps, conquer, scamper, clamber, Flambro.
5. *The* errors *will-be put* right *while you* remain *at-the* office.
6. Please get *to know whether the* Manager *will call on*-Monday *or* Wednesday.
7. *The* position *of-the* logogram *for* "*whither*" *is through-the* line.
8. Arthur Walsh *will* prepare *the* food *while we see to-the* invoices.

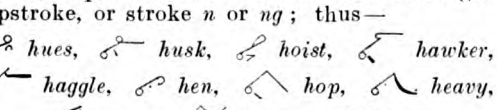
Key to Exercise 43

The Aspirate.—In Lesson VI some rules for the writing of the two alphabetic forms for *h* were given, and it will be well to recapitulate these at this point.

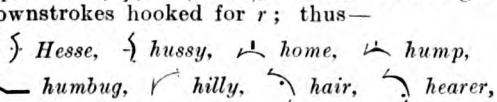
Downward *h* is written when it is the only consonantal sign in a word, and when *h* is followed by simple *k* or *g*; thus—


hue, hack, hag.

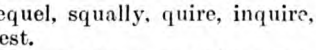
Upward *h* is written when followed by a circle, loop, or hook, or a downstroke or straight upstroke, or stroke *n* or *ng*; thus—


hues, husk, hoist, hawker, haggle, hen, hop, heavy, hurry, honey, hang.

Tick H.—In addition to the above methods of writing the aspirate, there are two other ways of indicating *h*. A short tick, having the same slope as downward *h*, is prefixed to *s*, *z*, *m*, *mp*, *mb*, *l* (up), *r* (down), *rer*, and to straight downstrokes hooked for *r*; thus—

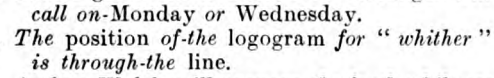

Hesse, hussy, home, hump, humbug, hilly, hair, hearer, hopper, Hebrew, heater, hedger.

Seeing that upward *h* is written before a circle, it follows that the tick is written to *s* and *z* only when they are followed by a final vowel; thus—


hazy.

There are only a very few words in which the tick and stroke *s* are used, and the tick is introduced to obviate a more or less awkward joining which would result if the stroke *h* were used.

Dot H.—If the stroke *h* were used medially on all occasions, some very awkward or impossible joinings would result. To get the best results a dot is used for *h* and is placed before a vowel which is to be aspirated; thus—


apprehension, unhealthy, vehicle.

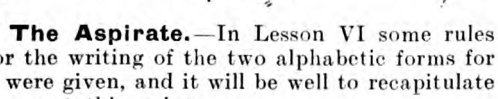
This dot *h* is generally used medially, and especially in the endings, *-ingham*, *-head*, *-hill*, *-hole*, *-hood*, as in—

Sandringham, blockhead, uphill, airhole, girlhood.

When used initially, the dot for *h* is written to represent words derived from the grammalogues *happy*, *happen*, *half*, *heaven*, *hand*; thus—

happiness, happening, handmaiden.

When *h* follows another stroke, the circle of *h* must be so written that it cannot be read as circle *s*; thus—


deserve, behoof; absorb, behead; answer, unhinge; wiser, weigh-house.

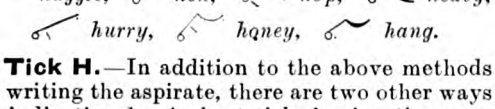
After initial *s* and *sh*, the downward *h* is written so that the circle of the *h* is inside the curve; thus—

Soho, Sheehy.

When *s* and *h* occur medially, the *s* is shown by enlarging the circle of the *h*, as in—

Fitzharry, racehorse.

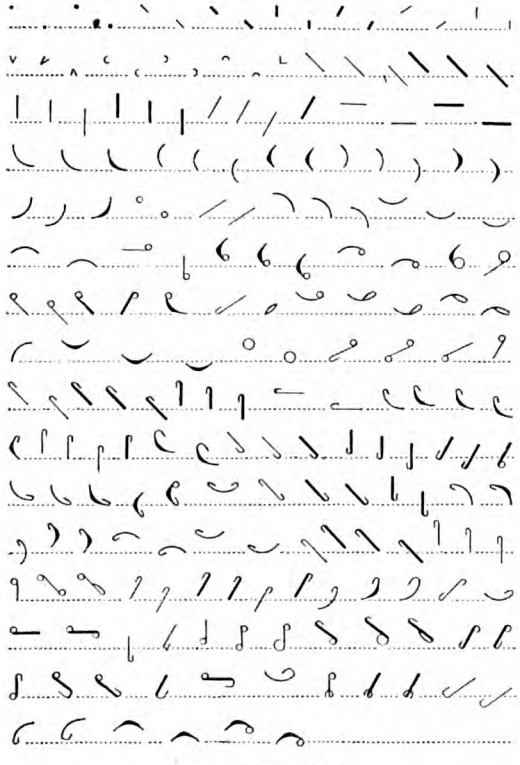
Exercise 44



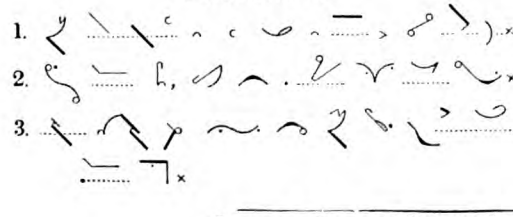
Key to Exercise 44

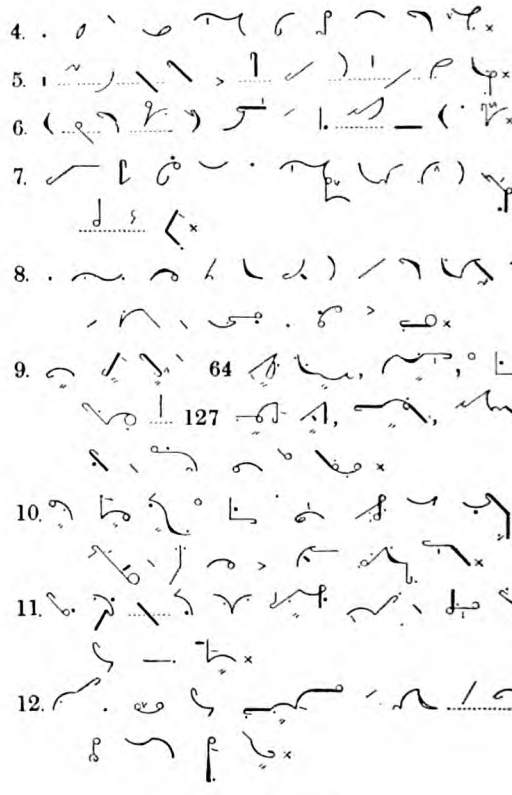
1. *We-shall-have to* hurry *if-we* desire *to* catch *the* Hackney bus.
2. *Mr.* Henry Hawkes *has* taken *the* honey *out-of-the* hive.
3. Harry Huggins bought *a* hammer *and a* hoe *at-the* Finningham Stores.
4. *We-think-the* ware*house is* unhealthy *and shall* adhere *to-our opinion.*
5. *The* Hampshire Hotel *is for* sale *and Mr.* Hull hopes *to buy it.*
6. *A* holiday *at* Harrogate *should* restore *your* health.

Revision of Grammalogues.—This lesson presents a favourable opportunity for revising the whole of the grammalogues taken up to this point. The best way to revise them is by taking them in groups as arranged in the various exercises. Below are given the various groups. The student should attempt to read them, and where any are not known, reference should be made to the back lessons, and the signs written out several times each. This work is most important.



Exercise 45





Exercise 46

1. Please *approve of-the above and* return *by* Friday.
2. *You-can* remedy *the evil and-we* look *to-you to-do it.*
3. *I-*am *generally down by-the sea during-the* summer-months.
4. *Within a* quarter *of an hour he-was* off *by-*train.
5. *The number of-the* cheque *was* unknown *to* Sam Dexter.
6. *We* regret *we-are* unable *to* allow *you any-more* time *in-which to* settle *the balance.*
7. *We-are surprised to-have yours of-*Wednesday, *and* assure-*you we-know Mr.* Young *as a very* honest fellow.
8. *Our Mr.* Hawkes takes-*the Northern* Counties *and he-will call-upon you* early *in* March.

Exercise 47

Mr. James Jackson.

*Dear-*Sir,

We-shall-be pleased *if-you-will call-upon us* early *in* March *and-*bring *with you a* varied selection *of-your* wall-papers suitable *for-the* better class *houses.* Last-*year we* ceased *our* connection *with* Brown *&* Jones *of-your* town *for* reasons well-known *to-you, and-if-you-can* suit *us, we-shall-be able to-give-you a large* share *of-our* business.

Yours-truly,

Thomas Stubbs.

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